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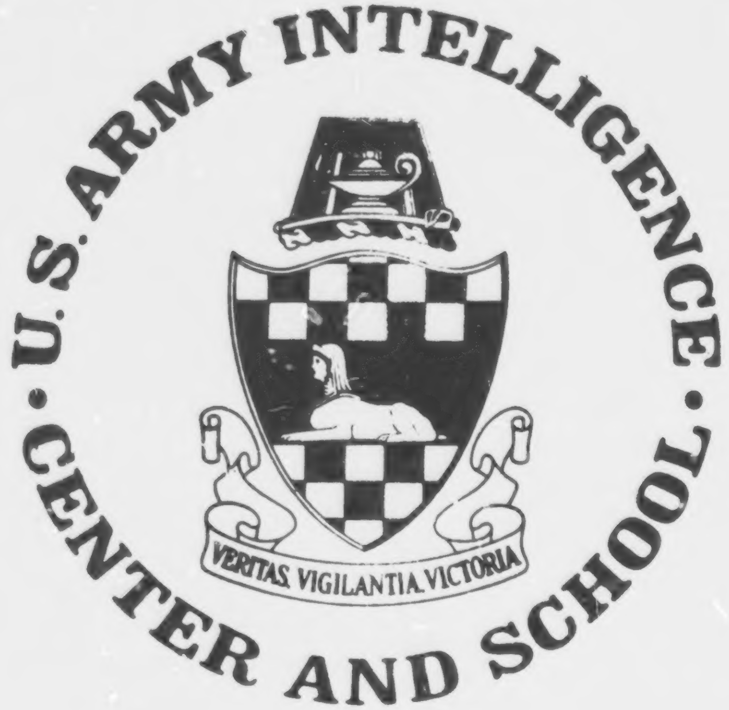
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FORT HUACHUCA, ARIZONA

ORIGINAL

COMMUNICATIONS - ELECTRONICS HANDBOOK

AN

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TACTICAL

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CHAPTER 1

INTRODUCTION

1-1 GENERAL

The organization of the communications systems described in this reference note provides a guide for the employment of the authorized equipment within units. All nets shown should be considered as type nets only and may be altered as required to fit the needs of any given tactical situation to support the accomplishment of a particular unit mission. The equipment portrayed herein conforms to the tables of organization and equipment (TOE) for infantry armor, and artillery units as of the publication date.

1-2 FIRST AID FOR COMMUNICATIONS PERSONNEL

a. General. First aid is the immediate and temporary care given to the victim of an accident, injury, or illness before treatment can be administered by trained medical personnel. Communications personnel often work in areas where medical personnel are not always immediately available; therefore, it is important that they be well trained in first aid procedures. When an injury occurs, the person applying first aid must evaluate the overall condition of the casualty and take appropriate measures. Some of the general procedures of particular interest to communications personnel are discussed below. For specific guidance, refer to FM 21-11, May 1970.

b. Treatment for electrical shock. In an electrical shock accident, quick rescue and application of artificial respiration are vital. If an unconscious person is in contact with a wire and you do not know definitely that the wire has been deenerginzed, assume that the wire is live. This is a dangerous situation, as a live wire can send electric current through the body of the victim to the rescuer. Exercise extreme caution to insure that the wire does not come in contact with the rescuer. Consider quickly, but carefully, rescue steps required.

(1) Wear rubber gloves and, if possible, rubber footwear in all rescue work involving electricity.

(2) Pull the wire clear of the victim with a dry rope or push the wire clear with a dry nonmetallic object, such as a board or other nonconductive object.

(3) If the victim is not breathing, apply artificial respiration immediately. SECONDS COUNT! Be calm! Think and act! The sooner you begin the artificial respiration, the more likely you are to succeed in restoring his breathing. If you are in doubt as to whether or not the casualty is breathing, do not waste valuable seconds but give him artificial respiration, as it can do no harm to a person who is breathing. If the casualty is breathing, you can ordinarily feel and see his chest moving or feel and hear air being expelled by putting your hand or ear close to his mouth and nose. There are two primary methods for administering artificial respiration--the-mouth-to-mouth method and the chest-pressure armlift method.

(For specifics of each, see paragraph 8b and c, FM 21-11.) The mouth-to-mouth method is the preferred one; however, it cannot be used if the casualty has a crushed face or is in a toxic environment.

(4) If the casualty has no heartbeat, administer closed-chest heart massage and artificial respiration simultaneously. SECONDS COUNT! Stoppage of heart is soon followed by cessation of respiration unless respiration stopped first. Be calm! Think and act! When a casualty's heart has stopped, he has no pulse at all, he is unconscious and limp, and the pupils of his eyes are open wide. To determine the presence or absence of the casualty's pulse, place the tips of your fingers on the left side of his neck near the windpipe. If you do not detect a pulse immediately, do not waste time checking further; start heart massage at once. Furthermore, if you find the casualty's pulse to be very weak and irregular, you must give him closed-chest heart massage and artificial respiration, as these signs indicate ineffective beats of the heart and precede heart stoppage.

(a) Closed-chest heart massage is the rythmical compression of the heart without surgicallly opening the chest. It is designed to provide artificial circulation in order to keep blood flowing to the brain and other organs until the heart begins to beat normally again. This is not the same as open-chest heart massage, in which the chest wall is cut open and the heart itself if compressed directly by hand. Since a casualty's breathing stops before or soon after his heart stops beating, artificial respiration must be administered with the closed-chest heart massage. If another person is available to help, one of you should give heart massage while the other one gives artificial respiration (fig 1-1). The two of you should coordinate your efforts so that one is not blowing into the casualty's airway at the same time the otherone is pressing on his breastbone. If you must administer first aid alone, alternate these measures.

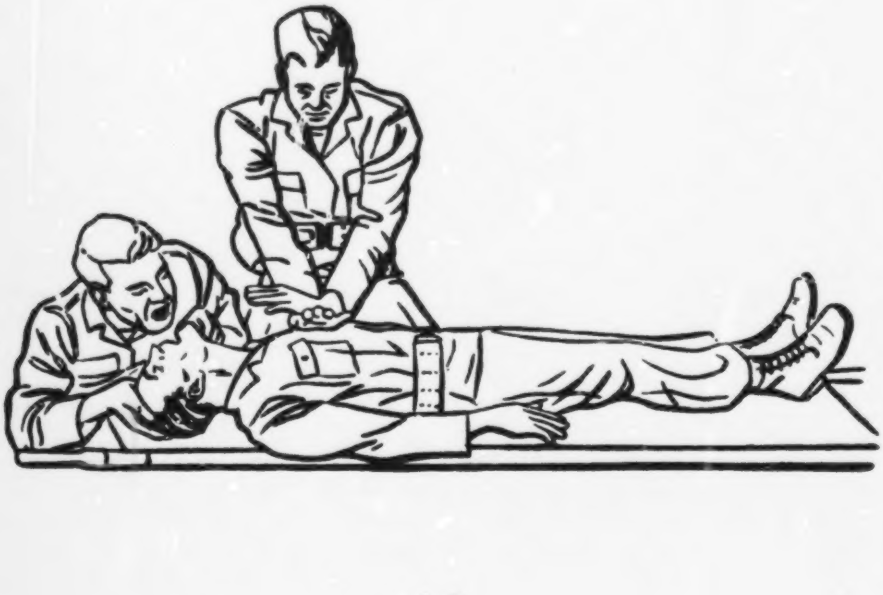

Figure 1-1. Closed-chest heart massage and mouth-to-mouth artificial respiration when two persons are available.

(b) To administer closed-chest heart massage, prepare the casualty for the mouth-to-mouth (nose) method of artificial respiration, placing him on a solid surface. A litter, the floor, or the ground is adequate; a bed or couch is too flexible. To position yourself, kneel at a right angle to the casualty's chest so that you can use your weight to apply pressure on the breast bone (fig 1-1). Place the heel of one hand on the lower half of the breast bone. Spread and raise your fingers so you can apply pressure without pressing the ribs. Place your other hand on top of the first. With your hands in the correct position and your arms straight, lean forward to bring your shoulders directly above the casualty's breastbone; then press straight downward. Apply enough pressure to push the breastbone down 1 1/2 to 2 inches. Too much pressure may fracture the casualty's ribs; therefore, do not push the breastbnone down more than 2 inches. Release the pressure immediately, lifting your hands slightly. Repeat the press-release cycle 60 to 80 times per minute. After a few minutes, check for pulse by placing your fingers on the casualty's neck. If only a feeble, irregualar pulse or no pulse can be dectected, elevate the casualty's legs about 6 inches above the level of his head to help the return of blood to his heart. Continue the heart massage and mouth-to-mouth resuscitation until the casualty is able to function without assistance, until you are relieved, or you are physically unable to continue.

c. Electrical burns. The treatment for electrical burns is identical to the treatment routinely administered for burns of other causes.

(1) Minor burns. Minor burns may be caused by exposure to dry heat, hot liquids, chemicals, electricity, or rays of the sun.

(2) Small burns that include blistering or charring. Since the skin is most likely to break when it is blistered or charred, cover it with a sterile compress to protect it from contamination and possible infection. Secure the compress with a bandage.

(3) Burns with no blistering or charring. If the burn does not blister, char, or break the skin, it is a minor burn even though it may cover a large area of the body as in mild sunburn. It is not necessary to cover such a burn with a sterile compress. A lubrication may be applied in a thin layer to relieve pain. Do not apply this lubricant to a burn in which the skin is blistered, charred, or broken.

(4) Sever burns.

(a) If a casualty has a burn that is blistered or charred, special first aid measures are required. The primary objective of first aid given to a burned casualty is to prevent or lessen shock and infection and to protect the burn against further contamination.

(b) If clothing covers the burn, cut and lift it gently away without touching the burn. Do not try to remove pieces of cloth that have stuck to the burn or to clear the burn in any way. Do not put ointment or any medicaton whatsoever on the burn.

(c) Place a sterile dressing over the burned area and secure it in place with bandages. In a mass casualty situation, a clean sheet may be used in the absence of sufficient dressings.

(d) Take appropriate measures to prevent shock.

Notes.

CHAPTER 2

ELECTRONIC WARFARE

2-1. GENERAL

Modern military forces depend increasingly on electronic devices for command and control of forces and employment of weapons. Such devices are used in signal communications, missile guidance and control systems, surveillance systems, radars, navigation aids, weapon guidance and fuzing systems, and many other military systems. Because of this dependence on electronic devices, modern military forces are becoming vulnerable to hostile actions that reduce the effectiveness of these devices or gain intelligence information from them. An electronic warfare (EW) system that enables the commander to degrade the effectiveness of enemy electronic activities is a powerful weapon that can be used to support both offensive and defensive operations. When all other pertinent considerations are equal, the final decisions of a military engagement will favor the force achieving superiority in the conduct of electronic warfare. New developments in the field of electronics and weaponry will continue to make it possible to electronically automate more functions on the battlefield. It will become increasingly important that all members of the Army be knowledgeable of electronic warfare.

2-2. TYPES OF ELECTRONIC WARFARE ACTIVITIES

Electronic warfare is a generic term that includes all the action taken to determine, exploit, prevent, or reduce hostile use of the electromagnetic spectrum and those actions taken to retain friendly use of the electromagnetic spectrum. It includes electronic support measures (ESM), which are information-gathering activities; electronic countermeasures (ECM), which include jamming and deception; and electronic counter-countermeasures (ECCM), which are measures employed to protect our communications capabilities.

2-3. ELECTRONIC SUPPORT MEASURES

Electronic support measures are those actions taken to search for, intercept, locate, record, and analyze radiated electromagnetic energy for the purpose of exploiting such radiations in support of military operations. ESM activities provide the operational information required for providing troop warning, target acquisition, threat detection, and other intelligence information that is vital to the conduct of day-to-day military operations. The planning and conduct of electronic warfare require considerable knowledge of the technical characteristics of enemy electromagnetic systems, enemy doctrine concerning their conduct of operations, and the tactical operational environment. Information gathering is vital to the successful establishment of both offensive (electronic countermeasures) and defensive (electronic counter-countermeasures) electronic warfare.

2-4 ELECTRONIC COUNTERMEASURES

Electronic countermeasures are intended to deny the enemy the effective use of the frequency spectrum. These measures include jamming and deception.

a. Jamming is the introduction of radiation into electronic receiving equipment in order to obscure or obliterate the information that would normally be received by the equipment operator. Any transmitter is a potential jammer if it can operate on the victim frequency. All types of electronic systems that depend on the reception of electromagnetic radiations are vulnerable to jamming. The most common of these systems are radio communication systems (including voice, CW, and radioteletype circuits) and radar systems (including proximity fuzing, missile guidance, navigational aids, and telemetry systems).

(1) Jamming methods. There are three basic methods of transmitting jamming signals.

(a) Spot jamming--Transmission of a narrow-band signal on a specific frequency or channel.

(b) Barrage jamming--Simultaneous interference on a wide band of frequencies or on adjacent channels.

(c) Sweepthrough jamming--An interference signal concentrated on a single frequency for only a short time as the jammer repeatedly sweeps back and forth across the band.

(2) Jamming signals. It is assumed that the enemy is constantly striving to divise new and more confusing forms of jamming signals. Any signal may be used, but some are more effective than others. Identification of the signal being used may be useful to higher headquarters in determining the jamming source. The signals are classified as modulated or continuous-wave. Some of the more common jamming signals are described in (a) through (h) below.

(a) Spark--A simple, easily produced, but effective jamming signal that consists of numerous bursts of noise of short duration, high intensity, and high repetition rate. The signal usually is much louder, or higher in level, than the desired signal; the sound is similar to that which an electric razor produces in some broadcast receivers. Because of the broadband characteristic of the signal, a number of channels can be covered by one jamming using this type of signal.

(b) Sweepthrough--A signal caused by sweeping, or moving, a carrier back and forth across a frequency band at a rapid rate. The resulting sound resembles that of a conventional aircraft engine. The type of signal is effective over a broadband of frequencies. With a high-speed sweep, the signal is effective against all types of voice-modulated transmissions.

(c) Stepped tones or bagpipes--A signal that is random both in amplitude and frequency with no periodically recurring frequency. This signal cannot be filtered out or other-wise eliminated without also removing the desired signal. It produces a sound similar to the rushing noise heard in an FM receiver when squelch is off, volume is maximum, and no signal is being received. It is especially effective because the operator may mistake the signal for normal receiver or atmospheric noise and fail to take antijamming action. Noise is regarded as one of the better types of jamming modulation and is effective against all types of radio transmissions.

(e) Random-keyed, modulated continous wave--A signal consisting of a continuous wave keyed at random and modulated. It may be used in air-dropable expendable jammers against voice channels, since it is easy to generate.

(f) Rotary--A signal that resembles a grunting sound. It is produced by a low-pitched, slowly varying audiofrequency and is used against voice-modulated transmissions.

(g) Voice jamming--Any transmission made by voice, such as singing, talking, chattering, or whistling.

(h) Miscellaneous signals--Other signals that are used as jamming signals for their nuisance value only (e.g., gull, pulse, tone, and wobbler).

b. Deception is the deliberate radiation, reradiation, absorption, or reflection of electromagnetic energy in a manner intended to mislead an enemy in the interpretation or use of information received by his electronic system. Deception is classified as manipulative or imitative.

(1) Manipulative--Alteration or simulation of friendly electromagnetic radiations to accomplish deception.

(2) Imitative--Introduction of radiations into enemy channels that imitate his own emissions.

2-5. ELECTRONIC COUNTER-COUNTERMEASURES

a. Electronic counter-countermeasures are those electronic warfare actions taken to insure effective friendly use of the electromagnetic spectrum in spite of the enemy's use of electronic warfare. Electronic counter-countermeasures include both preventive and remedial countermeasures.

(1) Preventive electronic counter-countermeasures are those measures taken by friendly forces to prevent the enemy from employing electronic warfare against the friendly forces. They also involve enemy deceptive measures. Some preventive electronic counter-countermeasures that can be taken are as follows:

(a) If possible, site the equipment with an obstacle between the transmitting station and the enemy. This may prevent the enemy from receiving the signal.

(b) Use directional antennas to reduce radiation of signals.

(c) Operate with the least power necessary to communicate with other stations in the net.

(d) Turn off transmitters when they are not needed.

(e) Use dummy antennas when performing maintenance.

(f) Employ random scheduling to prevent the enemy from anticipating operating time and planning EW activities in advance.

(g) Employ good radio techniques.

(h) Insist on signal security.

(i) Use applicable call signs and authentication procedures.

(2) Remedial counter-countermeasures are those actions taken by friendly forces after they have determined that the enemy is employing electronic warfare or when they have reason to suspect that he may be employing electronic warfare. Interference in a receiver may be caused by enemy electronic measures or it may be caused by defective equipment; therefore, the operator should first remove the antenna to determine whether defective equipment is the source of the interference. If the noise stops after the antenna has been disconnected, the problem is either enemy or friendly interference. In case of interference the following remedial actions must be taken:

(a) Carefully tune the receiver and adjust the bandwidth and volume controls.

(b) Increase power.

(c) Change operating procedures (e.g., reduce transmitting speed, change mode of operation).

(d) Use alternate means of communication.

(e) Use directional antenna.

(f) Relocate your transmitter to an area sheltered from enemy jamming signals (behind a hill, etc).

(g) On order, switch to an alternate frequency but continue to operate a dummy station on the frequency being jammed.

b. An operator whose station is jammed must report the jamming to his superiors. The jamming report should include, as a minimum, the date-time of jamming, the strength of the jamming, frequency on which jamming was experienced, type of jamming, and the identity of the reporting unit. The information contained in the jamming report often can be used by commanders to assess the capabilities and intentions of the enemy and to evaluate their own capabilities and requirements and to assist in locating the enemy jammer.

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Notes.

CHAPTER 3

TACTICAL COMMUNICATIONS DOCTRINE

3-1. GENERAL

The ability of a unit to effectively move and shoot depends largely on its ability to communicate effectively. The commander must rely on communications to control elements of his command, to gather information, to distribute intelligence, and to coordinate firepower. When planning tactical operations, the commander must plan his communications. Climatic conditions in an area of operations may pose problems in tactical signal communications planning. Special problems can be expected in desert, tropical, and arctic regions. Particular difficulties will arise in the protection of signal equipment and personnel and in the construction, operation, and maintenance of signal communications facilities and systems. Mountains, plains, rolling terrain, rivers, and forests also present problems to be considered by the tactical communications planner. These terrain features may present difficulties or advantages, depending on their location. Indigenous facilities must also be considered by communications planners. Included in this category are highways, transportation facilities, commercial communications facilities, power sources, and utilities.

3-2. COMMUNICATIONS RESPONSIBILITIES

The commander is personally responsible for the adequacy and proper use of the communications system within his command and for its efficient operation in the systems of the next higher headquarters. The authority to establish, maintain, control, and coordinate the employment of the various means of communication within a command may be exercised by a subordinate to the responsibility for these means connot be delagated.

a. Senior to subordinate. The commander of a higher echelon, or superior unit, is responsible for the establishment of communications with a lower echelon, or a subordinate unit. An attached unit is considered subordinate to the command to which it is attached with respect to placing responsibility for communications.

b. Supporting to supported. The commander of a supporting unit is responsible for the establishment of communications with the supported unit.

c. Reinforcing to reinforced. A unit having a reinforcing mission is res-ponsible for the establishment of communications with the unit being reinforced.

d. Lateral communications. Responsibility for the establishment of communications between adjacent units may be fixed by the next higher commander or may be established in the SOP. In the absence of specific orders fixing the responsibility, the commander of the unit on the left is responsible for establishing communications with the unit on the right facing the FEBA.

e. Maintenance. The commanders of both units are responsible for taking immediate and aggressive action to restore disrupted communications.

f. Common signal communications support. The Signal Corps is responsible for installing and operating common-user signal communications for combat, combat support, and combat service support units. Communications provided will complement, but not duplicate, the organic communications capability of the unit and will be consistent with tactical, administrative, and logistical requirements. Such a communication facilities complex is called a signal center. Signal centers in the tactical signal communications system are normally responsible for establishing and maintaining all extension (access) facilities from the signal center to the units in the vicinity.

3-3 TACTICAL COMMUNICATIONS MEANS

a. General. The communications means available to the commander are radio, wire, multichannel, which are classified as telecommunications, and messenger, which is a physical means of communication. The composition of the means in each unit depends on the personnel, equipment, and transportation provided by the unit's table of organization and equipment and by the unit or higher commander. The various means of communication have different capabilities and limitations; consequently, they are employed so that they complement each other and so that total dependence is not placed upon any one means. Certain means of communication are more effective than others under given circumstances. Selection of the most appropriate means is made by weighing such factors as operational urgency, installation time, transmission time, susceptibility to enemy action, reliability, and cost in resources. Command and control are jeopardized when dependence is placed on fewer means and strengthened when reliance is spread to a variety of means. In the selection of the most appropriate means, the prime consideration is normally the urgency of the operation requirement. The reliability of communications systems is greatly increased by planning and careful selection of alternate communications means. In brief, the means employed in a given situation generally are those that provide the maximum reliability, flexibility, security, and speed.

b. Radio communication. The most important characteristics of the radio sets used by the Army are presented in chapters 5 through 9. To be capable of operating together, radio sets must have common or overlapping frequency ranges, must be of the same type of modulation, and must transmit and receive the same type of signal. In addition, the stronger set must be kept within transmitting range of the weaker set. The operating ranges listed are for average conditions; the ranges obtained may be more or less than those listed as average, depending on the skills of the operator. Powerlines and steel structures close to operating sites reduce operating ranges. Radio communication is subject to natural interference (static), interference from other radio stations, and deliberate interference (jamming) by unfriendly forces. Its reliability depends largely on the skill of the operators. The tactical situation and the characteristics of the radio sets dictate their employment.

c. Wire communication. Wire communiction generally affords more security than radio communication, but the security of classified information transmitted in the clear cannot be assured. The decision to establish wire communicaton depends on the need for it, the time available to install and use a wire communication system, and the capability to install and maintain the system.

(1) Range. When battery-operated telephones are used, the planning range of field wire circuits is from 22 to 38 kilometers. When sound-powered telephones are used, the planning range is 9 to 16 kilometers. In short, the range of wire communication varies, depending principally on the weather and the condition of the wire. Wet weather, poor splices, and damaged insulation will reduce that range appreciable.

(2) Installation time. More time is required to install wire communication than to install any other means. The time required will depend mainly on the length of the lines and the method of laying (vehicle, aircraft, or on foot). Other factors to be considered in estimating the installation time are the personnel available and their training, the terrain, routes, weather, and visibility.

d. Multichannel.

e. Messenger communications. Messenger communications is flexible, reliable, and the most secure of all means of communication. Its speed depends on the messenger's mode of travel, whech may be by foot, motor vechicle, or aircraft. It is only means available for transmitting large-size maps and documents. Messenger service has some limitations, however. It is vulnerable to enemy action in forward areas, does not afford person-to-person conversation, and requires more time. Messengers are used when security dictates or when messenger service is faster than other means. Messenger service is an effective means for delivering long messages over short distances. Messenger communication is a supplementary means available to all units. The efficiency of messenger service depends on the selection and training of the individuals who serve in this capacity.

g. Integration of radio and wire communications systems. Wire and radio are separate and distinct means of communications. They may be integrated by using radio in conjunction with wire equipment.

3-4. COMMUNICATIONS CHARACTERISTICS

The more important characteristics of a communications system are reliability, speed, security, flexibility, and economy. Although all of these characteristics are interrelated, they are not necessarily completely compatible. Emphasis placed on one characteristic may degrade another. For example, the importance of speed may outweigh the need for security. Generally, a carefully applied balance of all the characteristics will provide an effective and efficient communications system. Emphasis placed on any characteristic such as the necessity for speed will vary with the mission of the unit, the tactical situation, and the commander's judgement.

a. Reliability is paramount in all circumstances. The term includes accuracy of communications. This characteristic is achieved by the application of the techniques of multiple means, alternate routing, and reserve equipment. Over emphasis on economy or overcommitment of communications will seriously impair reliability and flexibility.

b. Maximum communications security is obtained by employing every safeguard consistent with operational requirements. Effective security depends on a prior balance between security controls and operational urgency.

While engaged in combat operations, the local commander may authorize transmission in the clear (plain text form); however, this action should be taken only when, in the commander's judgement, a time delay to encrypt would jeopardize his command and when the information to be transmitted will not afford the enemy a tactical advantage. The commander does not permit relaxation of security measures when such action could result in the compromise of the plans of a higher commander or of a cryptographic system outside his immediate command.

c. The means of communication in any command exist for the primary and exclusive use of the commander and those personnel he designates. The use of these means is kept to the minimum consistent with the mission or objective of the commander. The application of means of communication is not intended to encourage a conservative attitude toward the full employment of the means available, but to discourage their use for purposes other than those for which intended. These means exist as a tool for the commander and his staff, not as a general command convenience.

3-5. COMMUNICATIONS IN TACTICAL OPERATIONS

The type or means of communication employed in a tactical operation depends on the type of operation, the tactical situation, and the means available. Coordination of tactical communications, electronic warfare, and other electronic facilities is essential to the success of tactical operations.

a. Command post location. The command post location of the unit controlling the operation should be located to facilitate communications. An improperly located command post may delay the establishment of communications at a critical time or make maintenance of effective communications impossible. The principle considerations for the command post location with respect to communications include--

(1) Effects of distance and terrain.

(2) Necessity for wire routes to the front and rear (to permit the prompt establishment of wire communications when possible).

(3) Effect of powerlines and electrical stations.

(4) Proximity to suitable terrain for a helipad or an airfield.

(5) Necessity for line-of-sight locations visible only to friendly troops (for use of visual communication).

(6) Routes of communication and traffic conditions. Since all communications facilities center at the command posts, roads into and out of it and the traffic to be expected on these roads influence its location. Messengers, wire teams, command vehicles constantly use the communications routes from the command post to subordinate and higher units. The absence of suitable communications routes causes delays and makes tactical control difficult.

b. Assembly area. To prevent enemy detection, communications security is exercised in all phases of selection and use of communications means. The following means of communication are provided at the assembly area:

(1) Messengers operate from each established signal or communications center. For security reasons heavy reliance in normally placed on messengers.

(2) Use of visual and sound signals is restricted in the assembly area, since every effort must be made to prevent detection by the enemy of friendly troop concentrations.

(3) Radio communication in the assembly area normally is restricted or silenced. Exceptions to this are warning broadcasts and transmission from reconnaissance forces in contact with the enemy. All radio sets are serviced and tuned to frequencies prescribed for the planned operation by the current CEOI and testing on radio frequencies allocated for the operation should be avoided as far as practicable in order to avoid communications security (COMSEC) violations.

(4) Wire communications in the assembly area will be limited. Existing commercial installations will not be used without express permission by the division communications-electronics officer (C-E off). Permission must be granted on a case-by-case basis.

c. Marches and halts.

(1) General. To insure that minimum essential communications are provided during marches and halts, the communications-electronics officer must receive advance briefing on the march plan. When practical, he should make a reconnaissance of the route of march to determine whether radio relay or retransmission stations are needed to maintain continuous communications.

(a) When aircraft are available for column control, communications facilities for contact with such craft should be dispersed within the column. During periods of radio or listening silence, prearranged visual signals may be used for communication between air and ground vehicles.

(b) In addition to communication instructions, march orders normally include the location of the march command posts. Communications information already covered in SOP may be omitted.

(2) Tactical march communications.

(a) Messengers are employed by all units during a march. Foot and motor messengers are used from front to rear and between adjacent columns. If aircraft are available, air messengers may also be employed.

(b) Visual communications are used extensively and they normally include panels, hand signals, and pyrotechnics. Prearranged visual signals employing these methods and devices are used to warn of impending hostile attack and to identify friendly columns and specific vehicles, march command posts, and message drop and pickup points.

(c) When radio communication is permitted, it provides a rapid and effective means of controlling the march. However, the employment of radio may be restricted for security reasons.
(d) Wire normally is not installed during a march.

(3) Administrative marches. This type of march is made when no enemy ground interference is anticipated. Therefore, radio and mounted messengers are the principle means of communications.
Radio security must be maintained to reduce or deny the enemy information. When feasible, wire will be installed at the new headquarter's location prior to the arrival of the marching units.

(4) Communications during halts. During temporary halts, communications are maintained as they were during the march. During extended halts, wire may be installed, but the amount will depend on the need for telephone facilities, the supply of wire available, and the duration of the halt.

d. Communications during offensive operations. Communication during an offensive operation is as follows:

(1) Messengers are used to the extent possible during the attack; however, speed is essential and will, in part, determine the type of messenger to be employed and the nature of the traffic to be transmitted by this means.

(2) Visual and sound communications should be employed during the attack to transmit prearranged messages in accordance with CEOI instruction.

(3) Radio communication prior to enemy contact is usually restricted to listening silence to preserve the element of surprise. After an attack is launched, special restrictions on radio and multichannel radio operations are, as a rule, removed and radio becomes a primary means of communication. Radio security, however, must be maintained, since radio traffic is a lucrative source of intelligence for the enemy. Radio stations should maintain normal loads of traffic as a deceptive measure to keep from alerting the enemy to new or impending changes in attack plans.

(4) Wire communication in the attack is secondary to radio communication. The time available, the tactical situation, and the supply of wire and personnel on hand are limiting factors governing the extent of the wire system that can be installed.

e. Communicatons in the defense.

(1) General. How elaborate a communications system will be in a defensive situation generally depends on the time and communication facilities available. Advance and duties are similiar to those for the attack, but the communications system is more elaborate and inclusive. Time usually is available to improve the system, including selection and preparation of alternate command posts that are located further to the rear than those in the attack. The form of defense adopted will influence the type of communications needed as indicated in (a) through (d) below.

(a) When the mission requires retention of specific terrain, the commander may adopt and area defense and place primary reliance on the ability of fires and forces deployed on position. In a situation like this, wire and messenger communications are emphasized.

(b) If a mobile defense is conducted, primary reliance is placed on manuever, fire, and offensive action to accomplish the defensive mission. In this situation reliance is placed on radio and messenger communications.

(c) When either type of defense is adopted hastily, the communication vacilities readily available are used. These facilities are supplemented as the time and the tactical situation permit.

(d) In general, a well-organized and strongly prepared defense will permit a more extensive employment of tactical communications.

(2) Application of communication in defense. In the defense, the communications system interconnects all major command elements and provides entry into the communications system for the covering force, outposts, and the reserve as required. Entry into the system may also be required for other units and activities such as airfields, attached troops, combat service support activities, and various echelons of the force headquarters. The communications utilized are as follows:

(a) Special messengers may be required during the organization of a defensive position. After organization is complete, the messengers normally revert to scheduled messenger runs.

(b) Visual signals may be used to your advantage in the defense as in other situations. Panels or other visual means can and should be used to mark frontlines. Panel stations may also be established to pass brief messages using prearranged codes.

(c) Radio communications are subordinate to wire facilities and messengers. Radio nets normally remain open, but on listening silence, to supplement or replace the existing means of communication if necessary. However, during the initial phases of a defensive operation where security permits, radio may be employed to satisfy heavy traffic requirements.

(d) Wire communications are employed extensively and are made as elaborate as time and capabilities permit. High-priority lines are established as rapidly as possible. Thereafter, additional circuits are installed to increase traffic capacity and flexibility.

f. Retrograde movements.

(1) General. In general, friendly forces that become involved in retrograde operations are usualy involved in some combination of withdrawal, delaying, and retirment actions.

(2) Application of communications during retrograde movements. During preparation for a retrograde movement, the existing ocmmunications system should continue operating. An analysis of the usual communications activities is presented in (a) through (d) below.

(a) Messenger operations during retrograde actions usually increase. Some messengers are retained at the old CP site to insure continuance of messengers service to forces left in contact with the enemy.

(b) Visual signal and panels are used as a means of identification and marking for the withdrawl of units.

(c) Radio communications are regulated during all disengagements. For deceptive purposes, dummy stations may be used to maintain the normal level of message traffic at old positions as required.

As the retrograde action progresses, wire lines not required by retiring units or by the elements left in contact with the enemy are recovered. If recovery is impossible, the wire lines are destroyed by removal of random sections. When appropriate, march control points are provided by marking wire circuits along existing communications utilized is presented in 1 through 4 below.

1. Messenger of the unit making the passage will operate on a normal basis. Messenger traffic will be conducted between the two units involved as needed.

2. Visual communicatins are limited to prearranged identification signals such as arm and hand signals, panels, and pyrotechnics.

3. Radio, to a limited extent, will be needed for communications between the unit occupying the position and the unit making the passage of lines. The frequencies employed and the procedures adopted must be coordinated carefully by the units involved.

4. Wire communications of the unit passed through should remain unaffected. When possible, the unit making the passage should utilize these circuits to the maximum extent possible.

(c) Application of communications for a relief in place. During the relief in place, the communications facilities of the unit relieved should remain in place until an orderly relief has been accomplished. Facilities already utilized should continue in operation until they are taken over by the relieving unit or until the need for the facility ceases to exist. When secrecy is imperative, the relieving unit adopts all measures necessary to prevent the enemy from discovering any change in the tactical situation. These measures include continuing the use of call signs, radio frequencies, codes, and ciphers of the unit being relieved. The relieving unit should take over the existing communications facilities--especially will require the mutual consent of the units concerned. Such exchange is dictated by the urgency of the tactical situation.

1. Messenger support will be assumed by the relieving unit on a joint schedule established by mutual agreement between the units.

2. Radio nets of the unit being relieved will be continued in operation up to a time agreed upon by the communications-electronics officers concerned. To maintain security, the relieved unit should continue operation of its normal radio nets for a limited period after the relief has been completed. This will require coordination and agreement between the signal and the intelligence officers of the respective commands.

g. Airborne operations. Communications planning must be performed by phase, concurrent with the planning for the airborne operation. During the marshaling area commander, as most organic equipment is being prepared for airlifting.

(1) Messengers. Both special and scheduled messengers are frequently employed during the airhead phase of the operation. Air messangers (couriers) should also be used where possible.

(2) Visual and sound signals. Visual signals are used extensively in airborne operations for identifying friendly units and assembly points. Sound signals are used in the airhead for alerting and warning purposes.

(3) Radio communications. During the assualt, primary reliance is placed on radio communications with man-portable equipment used in the initial phases, and airdropped vehicular radio sets used as soon as available.

CHAPTER 4

PRINCIPLES OF RADIO COMMUNICATION

4-1. GENERAL

1. An understanding of communication systems and characteristics will enable you to better grasp the complexities of Electronic Communications Theory and doctrine. Your familiarity with electromagnetic characteristics and equipments will enhance your ability to assess friendly vulnerabilities and to make concrete recommendations for minimizing the effects of enemy EW. This chapter combines programmed instruction techniques with specific short answer questions to allow you to determine your own familiarity and knowledge of basic radio wave propagation and U.S. communications. Its completion will allow you to determine your weak areas and will provide a starting point for self-improvement.

ELECTROMAGENTIC RADIATION

1. Let's first discuss electromagnetic radiation. It is defined as "Radiation made up of oscillating electric and magnetic fields and propagated with the speed of light." The question naturally is: What does that mean? Visually the radiated RF energy coming from a tactical radio antenna looks something similiar to figure 1.

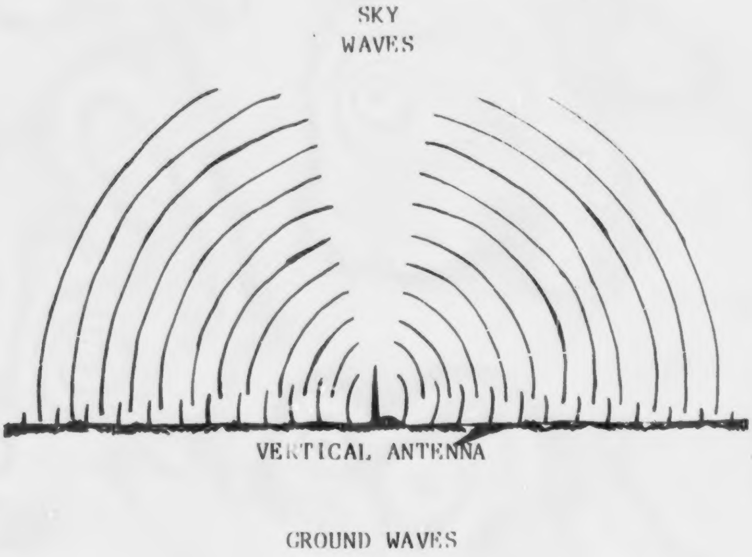


Figure 4-1. Radio frequency energy.

2. What one sees is a series of radiated electromagnetic pulses. These pulses or waves may either carry some form of intelligence, as in the case of voice transmissions, or may be pulses used by noncommunication equipment, for example, radars. In either case, all radio frequency waves have four things in common; FREQUENCY, AMPLITUDE, VELOCITY, and WAVELENGTH.

3. a. FREQUENCY is the number of times the cycle repeats itself in one second. Radio frequencies are often expressed in kilohertz or in megahertz. Kilo means thousand, and mega means million. Therefore, 6,000,000 hertz can be more simply written as 6,000 kilohertz (KHz) or 6 megahertz (MHz). Any frequency less than 20,000 hertz per second is considered as audio frequency, since it usually is audible to the human ear. Frequencies higher than 20,000 hertz are considered radio frequencies, since they can be subdivided into several bands of frequencies such as low, medium, high, and very high.

b. The number of times a cycle repeats itself in one second is called the __________.

c. The number of times a cycle repeats itself in one second is called the FREQUENCY.

4. VELOCITY is the speed at which the radio wave travels through space. This has been determined to be 299,000 meters per second. For most calculations, 300,000,000 meters per second can be used. This is equivalent to approximately 186,000 miles miles per second, which means a radio wave can travel a distance of eight times around the circumference of the earth in one second. REGARDLESS OF FREQUENCY, ALL ELECTRICAL WAVES ARE GENERALLY CONSIDERED TO TRAVEL AT THE SAME SPEED OR VELOCITY AS LIGHT, OR APPORXIMATELY 186,000 MILES PER SECOND. The actual velocity is subject to some variation depending upon the characteristics of the conducting medium.

5. AMPLITUDE is the instantaneous value of the alternating voltage, or current of the radio frequecy wave. Examination of figure 2 shows that as one proceeds to the right, along the time axis, a point moving along the alternating current (ac) curve is constantly changing in magnitude and direction. One notices that at the instant the point crosses zero, going either positive or nagative, the current reverses its direction, or alternates.

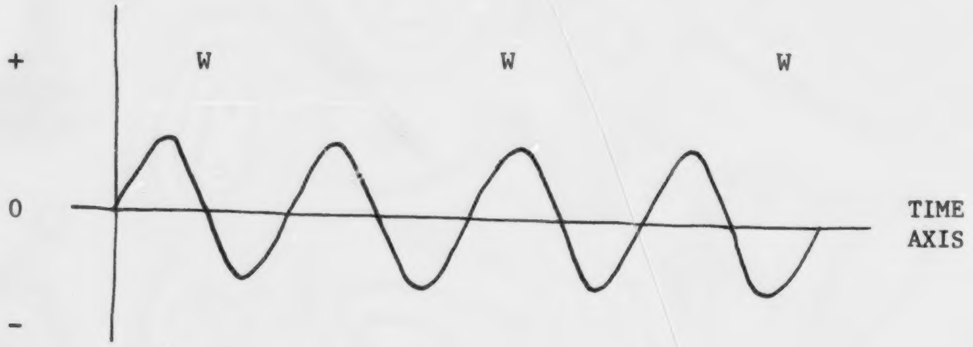


Figure 4-2. Amplitude--wavelength of an ac wave

6. WAVELENGTH is the distance measured between successive peaks of an ac wave (see fig 2). It can also be measured from the beginning of one cycle to the beginning of the next cycle, or form any selected point of one cycle to the equivalent point of the next cycle. Any of the above methods may be used, although the beginning-to-end method is the most common. Frequency and wavelength have an inverse relationship; the higher frequencies are shorter in wavelength than the lower frequencies. Figure 3 demonstrates the differences in wavelength between a wave of 2 MHz and 10MHz. The physical length of an antenna is determined by the wavelength of the operating frequency. Normally, the physical length of the antenna should be either 1/4 or 1/2 the wavelength of the operating frequency in order to have good communications. Therefore, the lower the frequency, the longer the antenna; higher the frequency, the shorter the antenna.

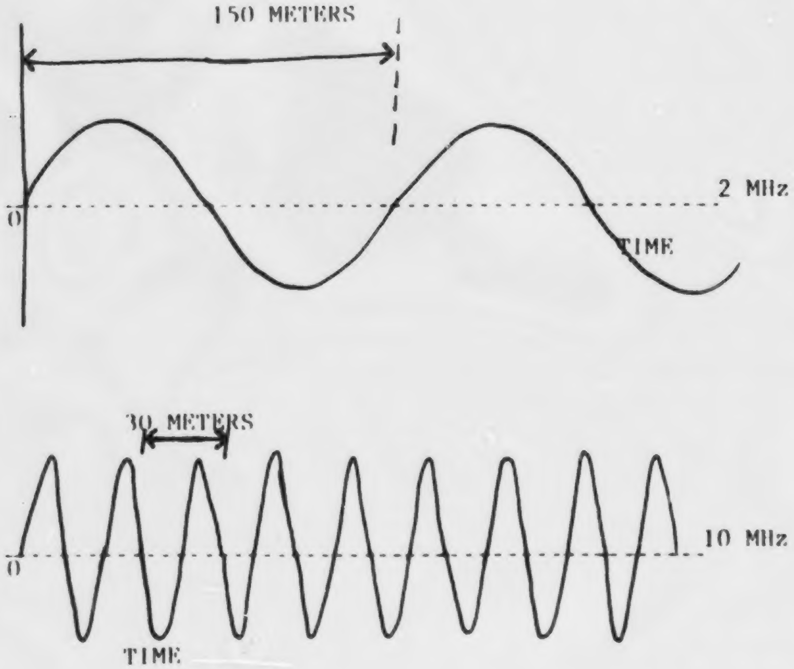


Figure 4-3 Comparison of two waves of different frequency.

When alternating current wave flows through a transmitting antenna, radio waves are radiated from it in all directions in much the same way that waves travel on the surface of a pond into which a rock has been thrown. Radio wavesare produced by sending an rf alternating current through an antenna element. The frequency of the wave radiated by the element will therefore be equal to the frequency, or number of hertz per second, of the rf alternating current. Since the velocity of the radio wave is constant regardless of its frequency, to find the wavelength (which is the distance traveled by the radio wave in the time required by one cycle), it is only necessary to divide the velocity by the frequency of the wave. This is an important relationship of radio communication.

$$\frac{300{,}000{,}000 \text{ (velocity in meters per second)}}{\text{Frequency (in hertz per second)}} = \text{Wavelength (in meters).}$$

Example: To find the wavelength of a radio wave with a frequency of 100,000 hertz per second:

$$\frac{300{,}000{,}000}{100{,}000} = 3{,}000 \text{ meters.}$$

This same relationship can be expressed in another way. If the wavelength is known, the frequency can be found by dividing the velocity by the wavelength.

$$300{,}000.000\ \frac{\text{(velocity in meters per second)}}{\text{Wavelength (in meters)}} = \text{Frequency (in hertz per second).}$$

Example: To find the frequency of a radio wave with a wavelength of 150 meters:

$$\frac{300{,}000{,}000}{150} = 2{,}000{,}000 \text{ hertz per second (or } 2{,}000 \text{ KHz).}$$

7. a. Radiofrequencies (RF) are classified as follows:

1. Very low frequency (VLF)--3 to 30 kilohertz (KHz) (KHz) equals 1,000 hertz).
2. Low frequency (LF)--30 to 300 kilohertz.
3. Medium frequency (MF)--300 to 3,000 kilohertz.
4. High frequency (HF)--3 to 30 megahertz (MHz) (1 MHz equals 1,000 KHz).
5. Very high frequency (VHF)--30 to 300 megahertz.
6. Ultrahigh frequency (UHF)--300 to 3,000 megahertz.
7. Superhigh frequency (SHF)--3,000 to 30,000 megahertz.
8. Extremely high frequency (EHF)--over 30,000 megahertz.

b. Frequency classification does not extend below 3 kilohertz because lower frequencies require considerable power to get the signal to travel any appreciable distance. The majority of stations operate in the bands from the medium through the ultrahigh frequencies; however, a few stations operate on frequencies in the very-low frequency band for special purposes.

c. The purposes for which these frequencies are used vary, depending on the propagation characteristics of different frequencies. In general, radiation is caused by varying currents traveling back and forth in the antenna. These currents cause an electromagnetic field to build up around the antenna. This field expands outward from the antenna at the speed of 186,000 miles per second and varies in strength and frequency with the antenna currents. An antenna is an electrical conductor used to radiate waves into space or to intercept radio waves in space. Antenna length is proportional to the length of the wave radiated. For a specified operating frequency, the length of a transmitting antenna is critical, whereas the length of a receiving antenna usually is not so critical.

8. a. List at least three classification of radio frequencies and their corresponding frequency ranges.

(1) ____.

(2) ____.

(3) ____.

(4) ____.

(5) ____.

b. The operating frequency and physical length of a wavelength have an ____________ relationship.

c. Radio frequency waves have four common characteristics. What are they?

a. ____________________

b. ____________________

c. ____________________

d. ____________________

d: (1) The classification of radio frequencies and their corresponding frequency ranges are?

(1)	VLF	3-30 KHz
(2)	LF	30-300 KHz
(3)	MF	300-3,000 KHz
(4)	HF	3-30 MHz
(5)	VHF	30-300 MHz
(6)	UHF	300-3,000 MHz
(7)	SHF	3,000-30,000 MHz
(8)	EHF	over 30,000 MHz

(2) The operating frequency and physical length of a wavelength have an Inverse relationship.

(3) Radio frequency waves have four common characteristics they are?

(a) Frequency.

(b) Amplitude.

(c) Velocity.

(d) Wavelength.

4-3 RADIO WAVE PROPAGATION

1. Prior to discussing the functional areas of a communications system, let's first discuss radio wave propagation. Radio frequencies are propagated in the atmosphere surrounding the earth's surface. Wave propagation deals with the properties and the nature of the atmosphere through which radio waves must travel from the transmitting antenna to the receiving antenna. The atmosphere is not uniform, but varies with the altitude, geographic location, time of day or night, season, and year. A knowledge of the composition and properties of the atmosphere aids in the solution of problems that arise in planning radio communication paths and in predicting the reliability of communications. The atmosphere consists of three layers: troposphere, stratosphere, and ionosphere.

2. The troposphere is that portion of the earth's atmosphere extending from the surface of the earth to heights of approximately 6 1/2 miles (10 km). Within the troposphere, the bending of radio waves by refraction causes the radio horizon to exceed the optical horizon. Tropospheric refraction (refraction caused by sudden changes in the characteristics of air in a lower atmosphere) affects the received signal at distances beyond the radio horizon. The stratosphere is that portion of the earth's atmosphere lying between the troposphere and ionosphere, about 6 1/2 miles to 30 miles (10 to 48 km) above the earth. The temperature in this region is nearly constant. The ionosphere is that portion of the earth's atmosphere above the lowest level at which ionization (splitting of molecules into positive and negative charges, or ions) of low-pressure gasses will affect the transmission of radio waves. It extends from about 30 to 250 miles (48 to 402 km) above the earth. The ionosphere is composed of several distinct layers in which ionization occurs at different levels and intensities.

3. a. There are three principle paths by which radio waves are propagated in the atmosphere and travel from a transmitter to the receiver. One is by direct waves, which travel directly from the transmitting antenna to the receiver. The second is by ground waves that either follow the contours of the earth's surface or are reflected by the ground to the receiving antenna. The last propagation path is the skywave, which travels up to the ionosphere and are bent downward, or refracted, back to the earth. Long-distance radio transmission is achieved principally by the use of skywaves. Short-distance transmissions are by means of either direct wave or ground waves. The navy uses ground (surface) waves as a means of long range communications but only by using high power for transmission. Some forms of transmission make use of combinations of all three paths.

b. The three principle paths for radio waves to travel from a transmitter to a receiver are: _________________, _________________, and _________________.

c. The three principal paths for radio waves to travel from a transmitter to a receiver are: direct waves, groundwaves, and sky waves.

4. a. Both groundwave and direct wave propagation refer to those types of radio transmission that do not make use of waves that have been refracted from the ionosphere. The signal strength of both are dependent on the transmitter power, the characteristics of the transmitting antenna, the frequency of the waves, the diffraction of the waves around the curvature of the earth, the electrical characteristics (conductivity and dielectric constant) of the local terrain, the nature of the transmission path, and local weather conditions. The direct wave is that component of the entire wave front that travels directly from the transmitting antenna to the receiving antenna. (Figure 4-4) This component is limited to the line-of-sight distance between the transmitting and receiving antennas, plus the small distance added by atmospheric refraction and diffraction of the wave around the curvature of the earth. This distance can be extended by increasing the height of either the transmitting antenna or the receiving antenna (or both).

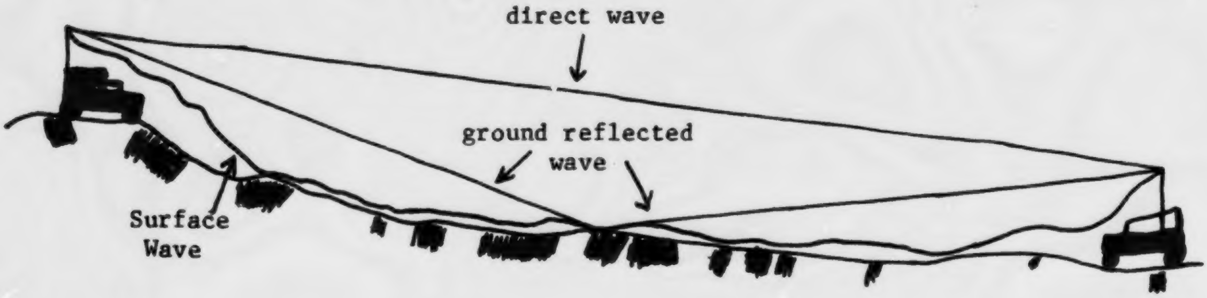


Figure 4-4. Direct wave and Groundwave components.

b. There are two components of a groundwave: surface wave and a ground reflected wave (See figure 4-4). The ground-reflected wave is the portion of the radiated ground wave that reaches the receiving antenna after being reflected from the surface of the earth. When both the transmitting and receiving antennas are on or close to the ground, the direct and ground-reflected components of the groundwave tend to cancel each other. The surface wave, which folows the curvature of the earth, is the component of the groundwave that is affected by the conductivity and die-lectric constant of the earth.

c. Three propagation paths from a transmitting antenna to a receiving antenna do not use the reflecting characteristics of the ionosphere. The ____________wave travels directly from the transmitting antenna to the receiving antenna:

Groundwaves essentially follow the contours of the earth or are reflected by it. Components of a groundwave are: ______________________________ __________ __________ which is reflected from the earth's surface; and the _ __________ ______________ which follows the curvature of the earth.

d. The direct wave travels directly from the transmitting antenna to the receiving antenna. Groundwaves essentially follow the contours of the earth or are reflected by it. Components of a groundwave are: ground reflected wave which is reflected from the earth's surface; and the surface wave which follows the curvature of the earth.

5. The remaining portion of the radiated energy from the antenna is sent up at an angle above the horizon, and is called the skywave. Part of this energy is returned to earth by the refracting effect, of the layers of free electrons that exist 70 to 250 miles above the earth's surface. These ionized layers, known as the ionosphere, can refract some of the key waves back toward the earth and produce a radio signal at points distant from the transmitter antenna (Figure 4-5. The amount of bending of the sky wave by the ionosphere depends on the frequency of the wave and the degree of ionization in the ionosphere, which in turn is dependent upon radiation from the sun. The sun increases the density of the ionosphere layers and lowers their effective height. Other solar and magnetic disturbances also produce changes in these layers. Radio waves therefore act differently at different times of the day, at different seasons of the year, and over different places on the earth's surface. The higher the frequency of a radio wave, the farther it penetrates the ionosphere and the less it tends to be bent back toward the earth. At low radio frequencies, the sky-waves are bent more easily, and penetrate less into the ionosphere.

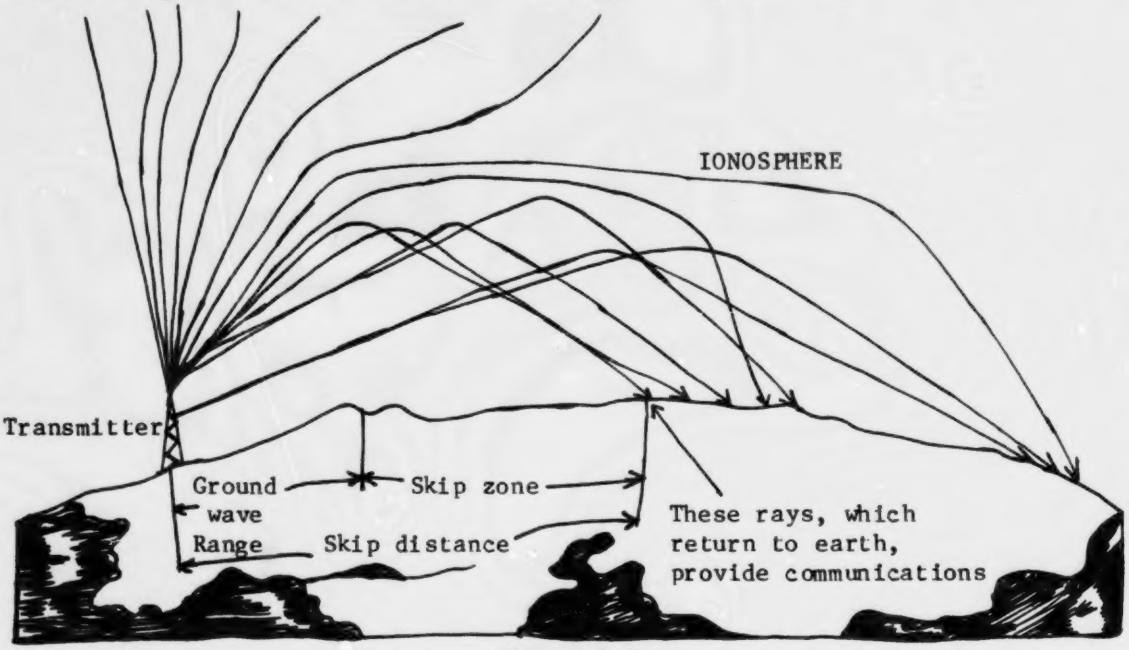


Figure 4-5

27

4-4 COMMUNICATIONS SYSTEM COMPONENTS

1. In radio communications, energy in the form of radio or electromagnetic waves is generated by electronic equipment and fed to an antenna by means of special transmission lines. The antenna radiates this energy out into space at the speed of light (approximately 186,000 miles per second or 300,000,000 meters per second). Receiving antennas, when placed in the path of the traveling wave, absorb a minute part of this energy and send it to the receiving equipment by means of a transmission line. For example, your car radio is a receiver and is capable of absorbing the electromagnetic energy generated by a commercial radio station and converting this energy to audible sound. Your car radio receiver is capable of receiving of the generating or transmitting antenna. The distance at which the signal may be received is dependent on transmitting power and atmospheric conditions.

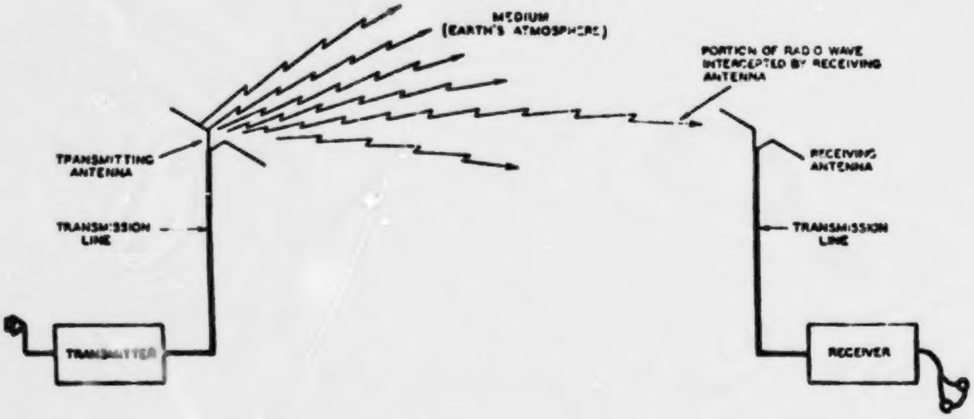

MEDIUM
(EARTH'S ATMOSPHERE)
PORTION OF RADIO WAVE INTERCEPTED BY RECEIVING ANTENNA
TRANSMITTING ANTENNA
RECEIVING ANTENNA
TRANSMISSION LINE
TRANSMISSION LINE
TRANSMITTER
RECEIVER

Figure 4-6. Simple radio communications network

Let's now discuss the basic components of a radio set. In order to transmit a message from one location to another by radio, the following basic equipment is required (see figure 4-6).

A transmitter that generates radio frequency energy waves.

A key or microphone used to control the energy waves.

Transmitting antenna to intercept some of the radiated RF waves.

A receiving antenna to intercept some of the radiated RF waves.

Receiver to change the intercepted RF waves into audio frequency waves.

A loudspeaker or headphones to change the audio frequency waves into sound.

2a. The primary purpose of a communication transmitter is to generate a radio frequency energy wave that has been modulated by intelligence. In order to learn the functions performed by the transmitter, one needs to first look at a relatively simple continuous wave transmitter (See figure 4-7).

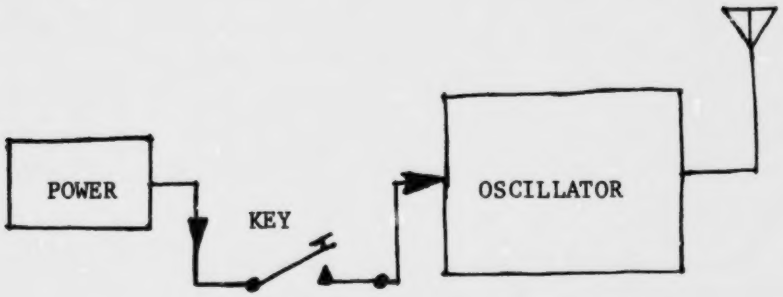


Figure 4-7. Block diagram of simple radio transmitter.

This transmitter consists of a power supply and a device known as an oscillator which generates radio frequency alternating current. The power supply may consist of batteries, a generator, or an ac-operated power source (commercial power). It is necessary to have some mehtod of controlling the RF energy generated by this transmitter if messages are to be sent by this means. The easiest way of doing this is to use a telegraph key (which is merely a type of switch for controlling the flow of electric current) connected with the power supply and the oscillator. When the key is operated, the power aplied to the oscillator is turned on and off for varying lengths of time to form dots or dashes of RF energy.

Since the RF power generated by the oscillator is normally insufficient to provide reliable transmissions over long distances, it is seldom used alone as a radio transmitter. To develop a higher power output, an rf amplifier is generally used in the transmitter to increase the strength of the oscillator's signal (figure 4-8). Such a transmitter is entirely satisfactory for practical purposes where only code transmission is desired.

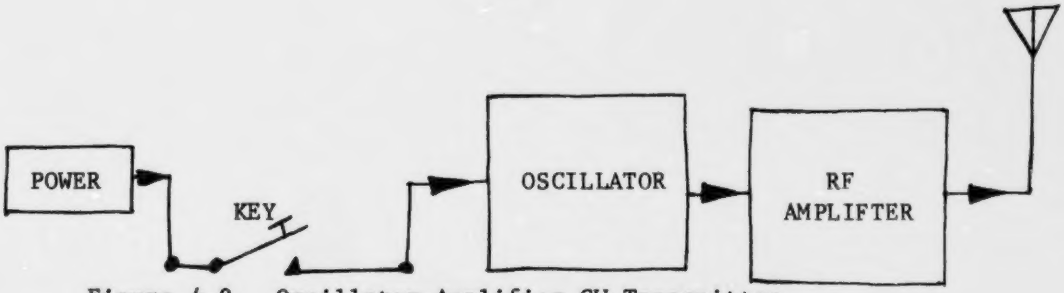


Figure 4-8. Oscillator-Amplifier CW Transmitter

b. The function of an oscillator is to generate ______________ alternating current for the transmitting.

c. The function of an oscillator is to generate radio frequency alternating current for the transmitter.

3a. In order to transmit messages by voice, however, it is necessary to find some way of controlling the output of the transmitter in accordance with the voice frequencies (audio frequencies). In modern transmitters this is done by means of a modulator which changes the output of the transmittter in accordance with the voice frequencies. Since the modulating signal varies the radio wave, the process is known as modulation, and an rf wave affected in this manner is known as a modulated wave. When the modulating signal causes the amplitude of the radio wave to change, the process is called amplitude modulation. When the modulating signal varies the frequency of the radio wave the process is called frequency molulation.

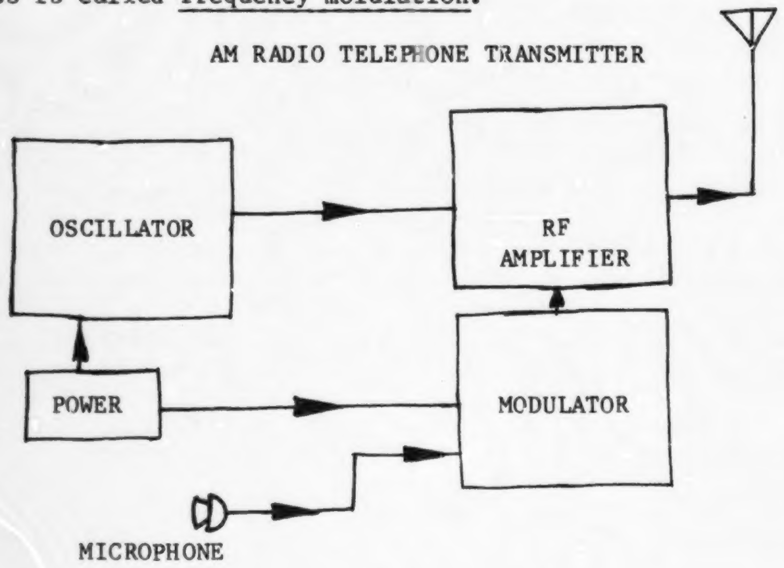


Figure 4-9. Block diagram of radiotelephone transmitter

Figure 4-9 shows the addition of the modulator and microphone to a transmitter, which is required to change the radiotelegraph transmitter into a radiotelephone transmitter.

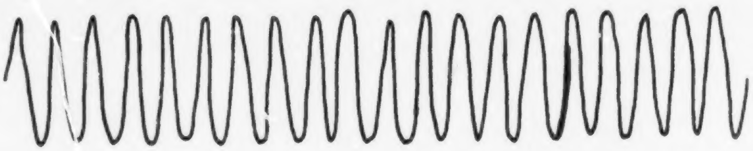
b. In order to pass voice intelligence, one must use a ________________ which changes the output of the transmitter in accordance with the __________ frequencies.

c. In order to pass voice intelligence, one must use a modulator which changes the output of the transmitter in accordance with the voice frequencies.

d. Amplitude Modualtion: When a radio wave (or carrier) is produced by a transmitter, the height of the wave is called amplitude. It is a measure of the power put into the carrier by the transmitter. The human voice produces a limited volume (amplitude) at any given frequency. In radio transmitters the amplitude of the voice is increased electronically or amplified. The amplified voice is then mixed (or modulated) with the carrier wave to produce a single Amplitude Modulated (AM) wave. This AM wave is then transmitted. Since AM is produced by combining amplitudes, and any extraneous electromagnetic waves, such as lightning, can attach themselves to the transmitted wave and will appear at the receiver as noise (interference). If the interference is so strong that it blots out the intelligence then we have lost a portion of our transmission. Also on the negative side is the comparatively high power output required to transmit an AM signal.

e. Frequency Modulation uses a carrier wave also. Modulation is also the means by which the intelligence is mixed with the carrier wave to produce a single wave. However in Frequency Modulation (FM), instead of modulating the amplitudes of the carrier and the voice, we modulate the frequencies to produce a modulated carrier. Let us say the voice at a given instant is producing a frequency of 1 KHz. The radio transmitter is producing a carrier of 45 MHz. When the two frequencies are modulated the results are two new frequencies which equate to the sum and difference of the original frequencies. Therefore, we have 45.001 MHz and 44.999 MHz. Electronically, within the transmitter we filter out and eliminate any frequency produced below 45 MHz and transmit any frequency above 45 MHz. Since the carrier frequency produced is constantly varying, the resultant output of the transmitter is a frequency modulated wave. Since the frequency is changing, the amplitude variations are no longer important to the intelligence. Therefore, they may be clipped off. Because of the clipping, which is accomplished by the receiver, any noise which attaches itself to the signal's amplitude is elimiated. This basically produces a noise free signal. The noise free signal is one of the primary advantages of FM. Additionally FM is well adapted to tactical operations because of its light weight equipment and short antennas it uses. On the deficit side FM is generally limited to short range communications.

4a. The transmitter that was discussed above is an amplitude moduated (AM) transmitter. The only difference in a frequency modulated transmitter is in changing a few components. and therefore will not be discussed. However, recognizing the difference in the output rf energy is worth considering. Let's do this by comparing the signals (figure 4-10). The first wave form is the RF carrier which is generated by the RF oscillatro in the transmitter.



A carrier

3'.

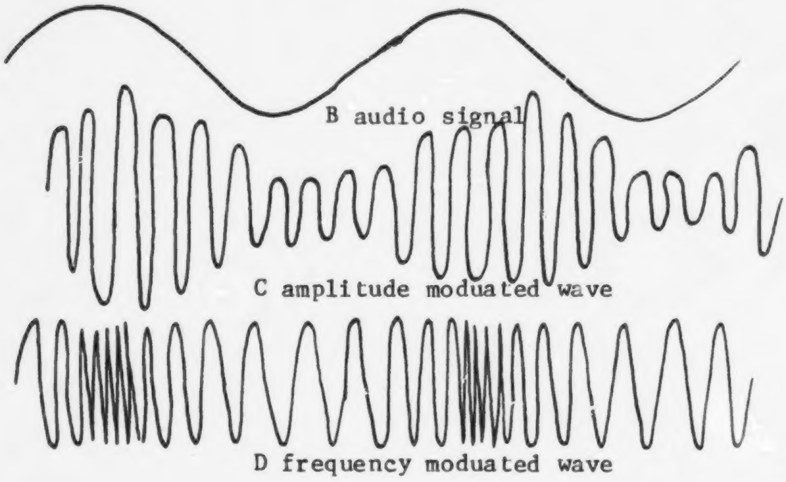


Figure 4-10. Comparison of amplitude-modulated and frequency-modulated waveforms.

The second signal is the audio signal received by the microphone and amplified by the audio frequency section of the transmitter. It was mentioned previously that amplitude modulation is the process of varying the amplitude of the carrier frequency by an audio signal. The third wave form is the signal that would be transmitted into space. One should notice that the amplitude of the wave is changed according to the audio signal. The last wave form is the signal that would be generated if you had a FM transmitter. In this case, an audio signal varying the carrier frequency. It should be noted that the change in frequency is not as large as it appears to be. We are only talking about varying the carrier frequency (e.g., 35 MHz) by an audio frequency of between 300 and 3500 Hzs (varies with type equipment used).

b. The process of varying the amplitude of a carrier frequency to transmit intelligency is called ________________; while varying the carrier frequency at an audio signal rate to transmit intelligence is called ____________________.

c. The process of varying the amplitude of a carrier frequency to transmit intelligence is called amplitude modualtion; while varying the carrier frequency at an audio signal rate to transmit intelligence is called frequency modualtion.

d. Principles of Pulse-code Modulation.

(1) Pulse-code modulation is a communication technique in which voice, data, or facsimile signals are converted into a series of digital pulse codes. Each pulse code represents signal amplitude at a particular instant and a series of pulse codes represents a complete waveform. Since the transmitted signal is in digital form, it is less susceptible to noise and distortion buildup over long distance lines, and may be regenerated at repeaters along the route without introducing additional distortion.

(2) Voice Transmission by Pulse-Code Modulation (PCM).

In the PCM process, standard amplitude levels are assigned and are represented by digital codes. The incoming voice signal is sampled at a high rate, and each sample is converted to a pulse at the closest standard amplitude, producing a pulse-amplitude modulated siganl. The standard amplitude pulses developed are then measured and converted to a binary pulse code for transmission.

e. In your own words; define line of a sight (LOS) and discuss how it applies to FM and AM communications.

f. Why are frequencies above 20 MHz most effective for line of sight communications?

5a. Let's turn our attention to the effect that the antenna has on the transmitted signal. Once an rf signal has been generated in the transmitter, there must be a means of radiating the rf energy into space and a means by which this signal can be intercepted (picked up) by the receiver. The device that fulfills both reguirements is called the antenna. Thus, the transmitter signal energy is sent out into space by a transmitting antenna. This energy is in the form of an electromagnetic field which is radiated through the atmosphere. When this is intercepted by a receiving antenna, it includes electrical voltage. If the receiver is tuned to the same frequency as the transmitter, the signal will be received, amplified, and made audible. The design and construction of a receiving antenna is not as critical for satisfactory operation as is the constructional details of a transmitting antenna.

The proper design of the antenna system is of the utmost importance in a transmitting station. The antenna must be able to radiate efficiently so that power supplied by the transmitter is not wasted. The transmitting antenna must be exact in its dimensions and properly constructed or poor efficiency will result. A complete transmitting antenna system consists of three distinct parts: the coupling device for transferring the output of the transmitter to the feeder; the feeder, or transmission line, that carries the energy to the antenna; and the antenna, which radiates the signal energy. There are many shapes and sizes of antennas used for radio transmission and several different electrical types of antennas. Some of the factors that determine the type, size, and shape of the transmitting antenna to be used are:

1. The operating frequency of the transmitter.

2. The amount of power to be radiated.

3. The general direction of the distant receiving set.

b. An antenna system consist of a (1) ____________________ which transfers the output of the transmitter to a (2) feeder or ____________________, which carries the energy to the (3) antenna, which radiates the signal energy.

c. An antenna system consist of a (1) coupling device which transfers the output of the transmitter to a (2) feeder or transmission line, which carries the energy to the (3) antenna, which radiates the signal energy.

6. An antenna is not merely a piece of wire or pole erected in any fashion, but is actually an electrical conductor which is cut to a specific length to match the carrier frequency being transmitted. The most efficient length for most antennas in 1/2 of a wavelength, which is known as 1/2 Lambda. To determine the required length of any antenna in feet for frequencies of 3 to 50 MHz, we have an easy formula. The formula states that the constant 468 divided by the frequency in MHz gives the length of the 1/2 wave in feet.

Example $\frac{468}{23.4}$ MHz = Lambda = 20 feet

With this formula, we may determine the length of any required antenna.

7. There are basically four common types of tactical antennas. These are the whip, the dipole, the reflector dipole and the long wire antennas.

a. The Whip antenna is a verticle antenna used for AM, Single side band (SSB) and FM transmissions. It is probably the most common type in tactical use because it is highly mobile, easy to erect, durable and quite efficient. This antenna radiates in an omni-directional pattern much like a large doughnut. Since a whip is limited in its physical length, it is usually electrically lengthened by use of wire loading coils which permit it to match the frequency being transmitted.

b. The common tactical dipole antenna is normally used with HF transmissions. It consists of two pieces of copper stranded wire joined in the center by a pair of wires from the transmitter and called a feeder. Its proper length is one half wavelength although it will operate at multiples of a 1/2 wavelength. The radiation pattern of a dipole is bi-directional. It radiates perpendicular to the long axis of the antenna. This pattern gives an advantage of transmitting the maximum signal in a desired direction. The disadvantages, however, to their radiation pattern lies with the normal employment of forces. Forward units in communicating to higher headquarters have one side of the antenna facing directly toward enemy lines.

c. Reflector Dipole is a dipole antenna with additional elements which cause the radiation pattern to emit in one direction. It therefore becomes a highly directional antenna. Because this reflector is generally larger than the radiating element, this type of antenna is normally used in the high VHF and UHF ranges where he antenna length is less than two feet. The principal advantange of this antenna is the highly directional nature of the radiated signal.

d. Field expediency is usually the case when a long wire antenna is used. It is constructed from a single piece of wire which is connected to the transmitter at one end and connected to, but insulated from, any convenient object above the ground at the other end. The length is normally 1 1/2 wavelengths or longer. The radiation pattern is emitted at about 30° to 45° away from the long axis of the antenna. The advantages of the long wire are its expediency and its reasonably directional radiation pattern.

8a. When power is delivered to an antenna, two fields are set up by the osilating rf energy: one is induction field, which is associated with the stored energy; the other is the radiation field, which moves out into space at nearly the speed of light (see figure 4-11). At the transmit antenna, the intensities of these fields are high and are proportional to the amount of power delivered to the antenna. Beyond a short distance from the antenna, only the radiation field remains. This radiation field is composed of an electric component and a magnetic component.

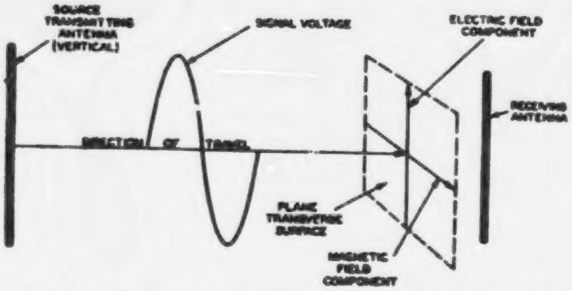


Figure 4-11. Components of electromagnetic waves.

The electric and magnetic fields (components) radiated from an antenna form the electromagnetic field, and this field is responsible for the transmission and reception of electromagnetic energy through free space. Thus, the radio wave may be described as a moving electromagnetic field, having velocity in the direction of travel, and with components of electric intensity and magnetic intensity arranged at angles to each other. The energy of radio signals radiated by an antenna forms an electromagnetic field having a definite pattern, depending on the type of antenna used. The radiation pattern is used to show both range and directional characteristic of an antenna. A vertical antenna theoretically radiates energy equally in all directions. In practice, however, the pattern is usually distrobed by nearby obstructions or terrain features. The full-or solid-radiation pattern is a three-dimensional figure that looks somewhat like a doughnut, with a transmitting antenna in the center.

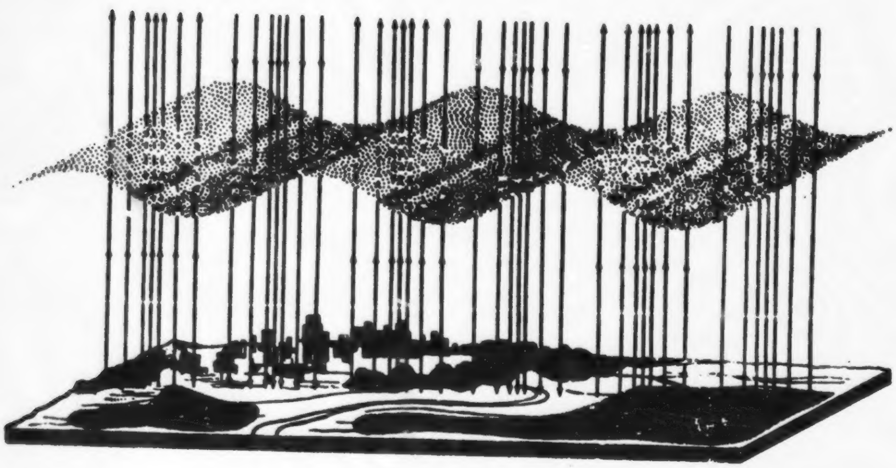
b. The radiation field developed when power is delivered to an antenna has two components: ______________ and __________________ fields which are responsible for the transmission or reception of electromagnetic energy through free space.

c. The radiation field developed when power is delivered to an antenna has two components, electric and magnetic which are responsible for the transmission or reception of electromagnetic energy through free space.

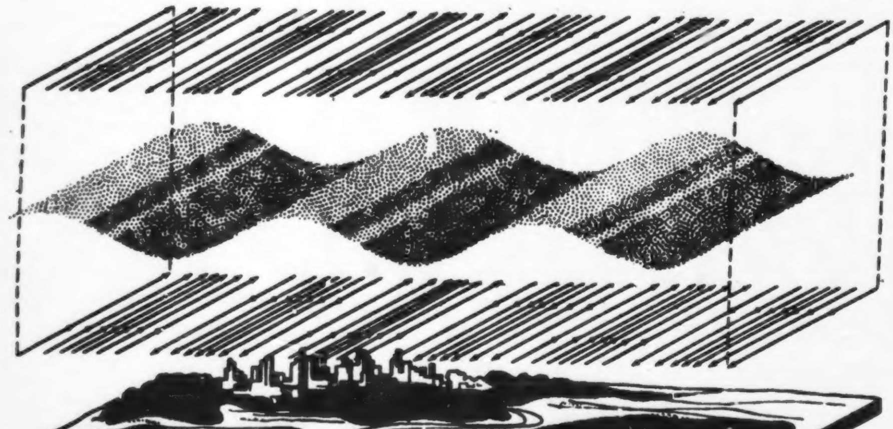
9a. Polarization of a radiated wave is determined by the direction of the lines of force making up the electric field. If the lines of electric force are at right angles to the surface of the earth, the wave is said to be vertically polarized. If the lines of electric force are parallel to the surface of the earth, the wave is said to be horizontally polarized.

(See figure 4-12). When a single-wire antenna is used to extract energy from a passing radio wave, maximum pickup results if the antenna is so oriented that it lies in the same direction as the electric-field component. Thus, a vertical antenna is used for efficient reception of vertically polarized waves and a horizontal antenna is used for the reception to horizontally polarized waves. In some cases, the field rotates as the waves travel through space. Under these conditions, both horizontal and vertical components of the field exist, and the wave is said to have elliptical polarization.

b. The direction of the lines of an electric force in the radiation field determines the ________________________ of the antenna.


DIRECTION OF TRAVEL

A VERTICAL POLARIZATION


DIRECTION OF TRAVEL

B HORIZONTAL POLARIZATION

Figure 4-12. Vertical and horizontal polarization.

c. The direction of the lines of an electric force in the radiation field determines the polarization of the antenna.

10a. Communication over a radio circuit is satisfactory when the received signal is strong enough to override undesired signals and noise. In other words, the receiver must be within range of the transmitter. Communication effectiveness can be increased between two radio stations by increasing the transmitting power, changing the type of signal (for example, changing from radio-telephone to CW), changing to a frequency that is not readily absorbed, or using a more directional antenna. In point-to-point communication, it is usually more economical to increase the directivity of the antenna system. Directional transmitting antennas concentrate radiation in a given direction and minimize radiation in other directions. A directional antenna may also be used to lessen interception by the enemy. An additional benefit is that interference with friendly stations is reduced (figure 4-13).

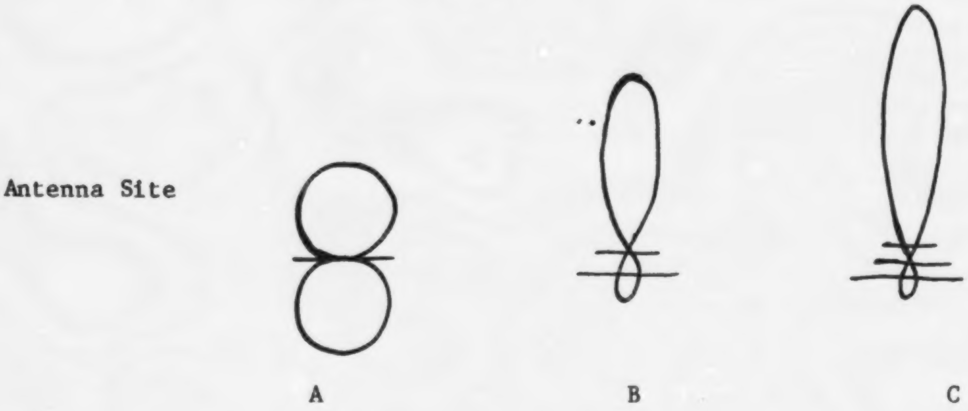


Figure 4-13. Radiation patterns of a half-wave antenna and parasitic arrays.

b. In figure 4-13, the radiation pattern in A is that normally associated with a half-wave antenna. By using element(s) placed to the rear of the antenna's radiating element the back lobe is reflected. Thus providing greater power (and range) to the front lobe and reduce the back lobe vulnerability to enemy ESM. B and C indicate the effects of increasing the number of parasitic elements. One sees that the basic function of a transmitting antenna is to convert the output power delivered by a radio transmitter into an electromagnetic field that is radiated through space. The receiving antenna makes the opposite conversion.

11a. A radio receiver operates in a manner different from that of the transmitter as previously discussed. Consider the diagram of a simple radio receiver (figure 4-14. Radio-frequency waves (from a transmitter) are reaching the antenna of the receiver. If a headset is connected directly to the receiving antenna in an attempt to receive the incoming radio waves, the attempt would not be successful, because the human ear will not respond to radio frequencies. A method is therefore needed whereby intelligence in the form of audio-frequency waves can be obtained from radio-frequency waves, and converted into sound by a headset. The circuit that is used in radio receivers to accomplish this is known as a detector (or demodulator), since it actually detects the incoming signal (radio wave). Since the radio transmitter is sending out radio waves at a certain frequency, the receiver must have some means of tuning in, or selecting the frequency of the desired radio wave. This is necessary to avoid receiving many radio signals of different frequencies at the same time.

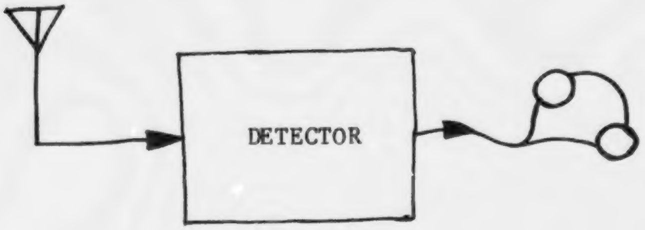


Figure 4-14. Block diagram of simple radio receiver.

b. In a radio receiver a detector is used to convert the received

__________ __________ __________ into __________
frequency waves.

c. In a radio receiver a detector is used to convert the received radio-frequency waves into audio frequency waves.

12. Because a radio signal diminishes in strength, or intensity, at a very rapid rate after it leaves the transmitting antenna, it is seldom possible to use a detector alone to receive the desired signal. The greater the distance between the transmitting and receiving antennas, the greater will be the reduction, or loss, in signal strength. By the time it reaches the receiver, the signal may be so weak that the sound in the headset is too faint to be useful. The actual radio frequency (rf) signal picked up by a receiving antenna in normal communication work is usually only a few microvolts, or millionths of a volt. In order to increase the level of the af output of the dectector to obtain satisfactory headset operation, an audi frequency (af) amplifier is used in most sets (figure 4-15).

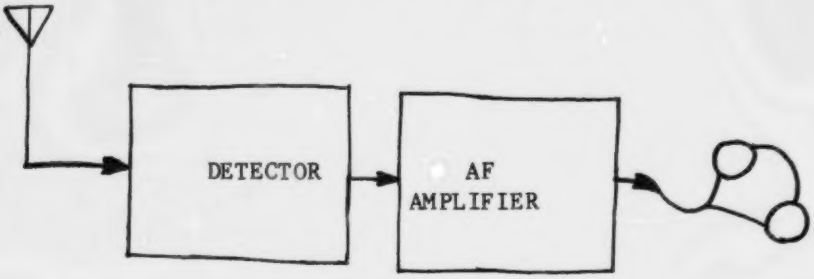


Figure 4-15. Block diagram of detector and af amplifier.

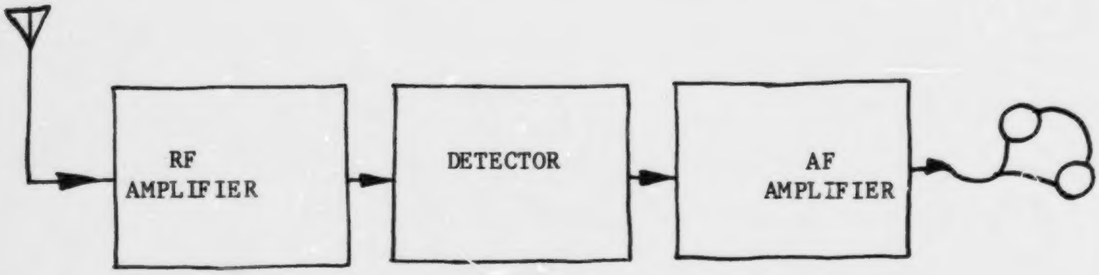


Figure 4-16. Block diagram of complete radio receiver.

13. If it is desired to increase the sensitivity (ability to receive weak signals) of the receiver, it is necessary to amplify the rf signal before it reaches the detector (figure 4-16. This is done by the use of an rf amplifier. The rf amplifier is provided with one or more tuned circuits, so that it amplifies only the desired signal. The addition of an rf amplifier to the receiver gives not only greater sensitivity but also greater selectivity (ability to discriminate between signals of different radio frequencies).

14. Single sideband (SSB) is an offshoot of Amplitude Modulation (AM). When an AM signal is produced by a transmitter, two sidebands or hetrodynes are produced. A hetrodyne is an even multiple of a frequency. The sidebands mirror the amplitude variations of the basic wave. Since the amplitude variations are really the amplified intelligence signal anyway, the sidebands are just another signal containing the intelligence, but minus the carrier wave. To transmit one sideband signal we may electronically eliminate the carrier and the other sideband, thereby presenting the final output stage of the transmitter with only one sideband. Though the sideband is amplitude modulated, its amplitudes are significantly smaller than those of the full AM wave and, therefore, require much less output power from the transmitter to achieve the same reliability. This reduction of required output power and conservation of the frequency spectrum are the principal advantages of SSB over AM. Additionally, the smaller amplitudes are less prone to interference.

15. International Morse Code (IMC) may be sent over AM, SSB or FM transmitter. However AM and SSB are the most commonly used modes. In the transmission of IMC the carrier is modulated with a tone in the voice frequency range (e.g., 1KHz). The transmitter is then set to transmit a continuous carrier wave containing the 1KHz tone. To make Morse Code, the continuous wave is interrupted by means of a key which when closing forms the "dots and dashes" which are formed into letters specified in the Morse Code. The advantages of IMC transmissions are that they are not as affected by extraneous frequencies, i.e., noise, as are voice transmissions. This is true because with IMC, the AM or SSB mode is wave modulated with only one frequency as opposed to voice modulation which uses may different frequencies at constantly varying amplitudes. IMC will continue to be utilized because of its ability to be understood through interference. On the deficit side IMC requires a fairly long period of instruction on an operator's part and constant practice is needed to maintain proficiency.

16. Principles of Multiplexing.

a. General.

Multiplexing is a method used to simultaneously transmit several channels of voice or data over a radio or cable link. There are two basic techniques of multiplexing: Frequency-division multiplexing (FDM), and time-division multiplexing (TDM).

b. Frquency-Division Multiplexing (FDM) allows the maximum number of stations to use the entire radio frequency spectrum. The bandwidth allotted to each radio frequency carrier can be subdivided into smaller bands separated by frequency devision, thus permitting the transmission of more than one independent signal on a single carrier. In FDM each independent stream of information is cause to modulate a different frequency, which is called a subcarrier because it may be much lower in frequency than the common RF carrier. The only requirement is that the subcarriers be separated in frequency by a sufficient amount to prevent interference between signals. After the individual subcarriers have been modulated, they are combined to form a complex wave which modulates the common carrier by one of the ordinary methods of modulation.

FDS may be used to combine several voice channels, several printer channels, or a combination of several different signals. Many newer communications systems make use of frequency-division multiplexing. Theoretically, an infinite number of channels could be multiplexed together using this technique; however, various intricacies of electronic theory place limitations on the actual number of channels which can be mixed together.

Communications systems using FDM are termed "multi-channel systems", but the analyst should not confuse this term with that used in time-division multiplexing.

c. Time Division Multiplexing.

In time division multiplexing (TDM), each voice channel is assigned a time interval in sequence with all other channels being multiplexed. These intervals are short and repeated at a high frequency. The samples taken from each channel are then converted to a form suitable for transmission in the selected medium. At the receiving terminal, the samples are demodulated and separated into their proper channels by a timing signal from the transmitting terminal. The simplified telephone circuit in figure 4-17 illustrates the time division principle.

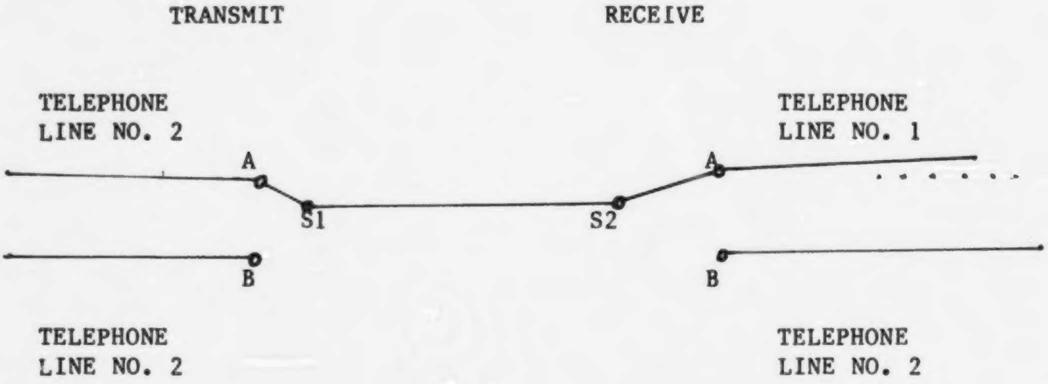


Figure 4-17. Simplified Telephone System Showing Simple TDM

Switches S1 and S2 are synchronized such that both are in position A at the same time, and in position B at the same time. A telephone call made on line A is completed only when the switches are in position A. The telephone calls made on line B are completed only when the switches are in position B. When both lines are in use the switches alternate between position A and position B. If the switching rate is low, both conversations will be garbled and unintelligence. If the rate is increased, the signals will be more intelligence. When the switching rate is higher than voice frequencies, the switching is not detectable. The circuit shown in figure 4-18 is a simplified 12 channel TDM system.

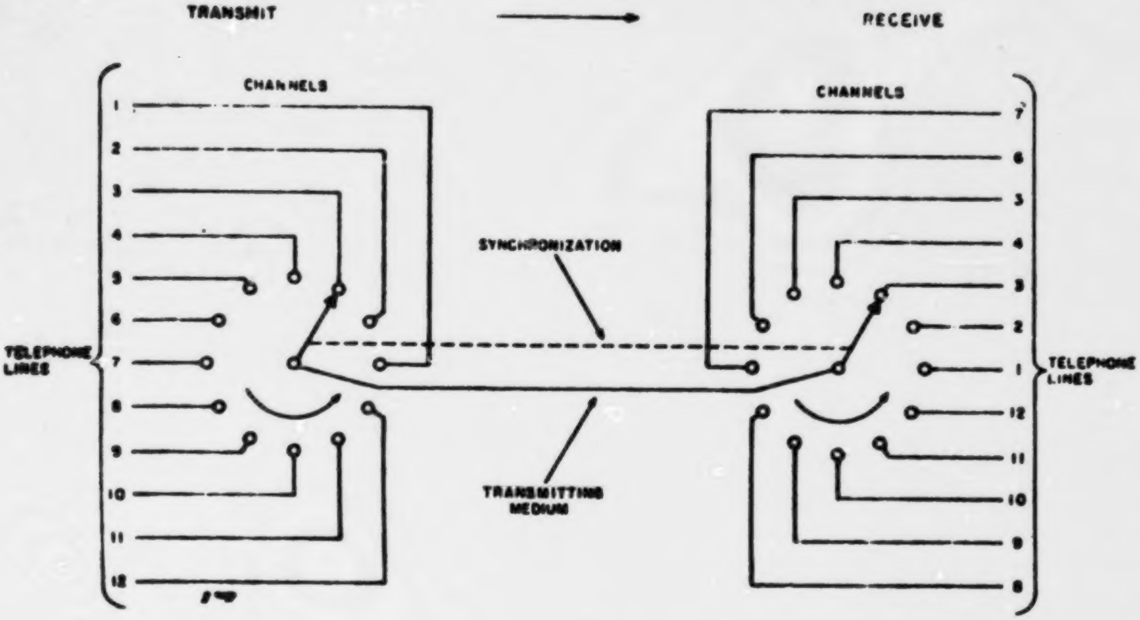

TRANSMIT
RECEIVE
CHANNELS
CHANNELS
1
2
3
4
5
6
7
8
9
10
11
12
7
6
5
4
3
2
1
12
11
10
9
8
SYNCHRONIZATION
TELEPHONE LINES
TELEPHONE LINES
TRANSMITTING MEDIUM

Figure 4-18. Simplified 12-Channel TDM System.

The two basic techniques used for multiplexing several different channels of communications are ______________-_______________ and ____________-______________ multiplexing.

Theorectically, an infinite number of channels could be multiplexed together using ________________-_______________multiplexing.

The method of multiplexing which depends high-speed sequential sampling of all channels is called ______________-_____________________ ________________.

The two basic techniques used for multiplexing several different channels of communications are frequency-division and time division multiplexing.

Theoretically, an infinite member of channels could be multiplexed together using frequency division multiplexing.

The method of multiplexing which depends upon high-speed, sequential sampling of all channels is called time division multiplexing.

4-5 COMBAT COMMUNICATIONS

1. The employment of communications-electronics equipment in the US Army has been left to signal corps officers and other personnel trained in electronics in the past. This approach has been satisfactory until the advent of electtronic warfare became a threat to division operations. With the threat that Soviet trained forces pose and our own development in the application of EW, it has become a requirement for all combat and combat support battalion S2's, and S3's, and CEO's to become "suffix 5M" qualified in order to plan and function effectively in the combat environment of the future. The Electronic Warfare Qualified Staff must know certain electronic fundamentals.

2. U.S. forces are extremely dependent on electronic systems for control of forces, surveillance assets and specific weapons systems. Radio communications, like any other system, have advantages and disadvantages. Discuss what you feel are strong points of radio communications?

What are disadvantages of radio as means of communications?

References: FM 24-1, page 3-9

3. What is electromagnetic compatability?

References: FM 11-50, page 3-9 and FM 24-1, page 4-10.

What are some techniques that can be employed to reduce local interference between communication and noncommunications systems?

Reference: FM 11-50, page 3-10.

4. Aside from the devastating results of a nuclear explosion, what other aspects of a nuclear blast will effect C-E systems and assembles?

References: FM 11-50, 4-15

Briefly discuss Electro Magnetic Pulse (EMP) as it relates to radio antenna.

Reference: FM 11-50, page 4-18 and FM 24-1, page 3-35.

What are the three variables of a nuclear blast that effect nuclear blackout and its effect on communicatons?

Reference: FM 11-50, page 4-20.

5. Terrain and weather effect C-E systems and their ability to function within required parameters. The Electronic Warfare qualified staff officer must consider these effects and their relationship to EW to effectively plan for its offensive and defensive aspects. How does cold weather conditions effect radio communications?

Reference: FM 24-1, page 3-32.

What effects will the desert have on radio communications?

Reference: FM 24-1, page 3-33.

When operating in wooded areas, what are some considerations to bear in mind concerning antenna siting and improving radio communications?

6. Planning the employment of communications assets in support of combat operations, is as important as planning the employment of any other combat weapon. The simplicity or complexity of the design of a communication system depends on the:

a.

b.

c.

d.

e.

f.

Reference: FM 11-50, page 4-1

In establishing communications, what basic principles should be followed?

a.

b.

c.

d.

Reference: FM 11-50, pages 2-3, 2-5.

7. What communications systems are available to a division commander?

Reference: FM 24-1, pages 3-8, 3-10, 3-19, 3-20.

8. The following are the basic, single channel radio nets you should know before discussing C-E requirements or EW protective measures at various echelons of a division i.e. Battalion, Brigade.

a. Command/Operations Net. This net is used for tactical control by commanders and for combat coordination and reporting of tactical data. Orders, coordination, and information of immediate command and operational value are types of traffic commonly passed over this net. Command/operations nets are normally given the highest priority for establishment.

b. Intelligence Net. This net is used as a real-time means for passing intelligence information and spot reports. The intelligence net is the back-up for teh command/operations and the intelligence net and is given the second highest priority for establishment.

c. Administrative and Logistics Net. This net is used for passing personnel and material supply information and requirements. This kind of traffic does not normally have the same immediate tactical importance as the traffic on the command/operations and the intelligence nets; therefore, the priority for establishment is lower.

d. Fire Direction Net. This net is used to pass the details of the missions and to control the actual firing elements within each firing unit. The fire direction net is normally associated with artillery and mortars. This net is activated as soon as possible.

e. Surveillance Net. This net is established by the battalion's battlefield information control center as a coordiantion and reporting net for the ground surveillance radar teams and unattended ground sensor teams. Typical intelligence information is of vital importance to commanders, the net is given a high priority for activation.

9. On the modern battlefield, we cannot expect to stay in one place for very long. Units will be moving back and forth, command posts (CP's) will be displacing for survivability and well as because of the fluidity of the battlefield, and communications, facilities will be required to support both new and old locations. Explain the principle considerations for the displacement of communications supporting a CP.

Reference: FM 24-1, 6-2, 6-3, 6-4.

10. Successful C-E planning includes considerations of what four features?

a.

b.

c.

d.

Reference: FM 11-50, page 2-6.

11. Since the cavalry squadron normally operates beyond the range of single channel, FM radio sets, what radio set is well suited for their maintenance of good communications?

Reference: FM 11-50, page 5-18.

12. What means of communications is most frequently used by a battalion on the move?

Reference: FM 11-50, page 5-9.

13. Who is responsible for providing direct support COMSEC logistics for a Division?

Reference: FM 11-50, page B-1.

14. A signal center is a group of communications facilities belonging to a signal unit, responsible for installing, operating, and maintaining the facilities necessary to provide communications to a command headquarters or units in a specific geographic area. All signal centers perform the same function and, for the most part, render the same services. However two specific catagories of signal centers exist - what are they and how do they differ?

Reference: FM 24-1, page 5-11.

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What components make up a signal center?

Reference: FM 24-1, page 5-10.

4-7. TABLE OF COMPONENT INDICATORS

Component indicator	Family name	Examples (Not to be construed as limiting the application of the component indicator to these items.)
AB	Support, antenna	Antenna mounts, mast bases, mast sections, towers, etc.
AM	Amplifiers	Power, audio, interphone, radiofrequency, video, servo (nonrotating), etc.
AS	Antenna assemblies	Complex: arrays, parabolic-type, masthead, etc.
AT	Antennas	Simple: whip or telescopic, loop, dipole, reflector; also transducer, etc. (See H.)
BA	Battery, primary-type	B-batteries, battery packs etc.
BB	Battery, secondary-type	Storage batteries, battery packs, etc.
BZ	Signal devices, audible	Buzzers, gongs, horns, etc.
C	Control articles	Control box, remote tuning control, etc.
CA	Commutator assemblies, sonar	Peculiar to sonar equipment.
CB	Capacitor bank	Used as a power supply.
CG	Cables and transmission line, RF	RF cables, waveguides, etc., with terminals.
CK	Crystals kits	A kit of crystals with holders.
CM	Comparators	Analyzes or compares two or more input signals.
CN	Compensators	Electrical or mechanical compensating, regulating, or attenuating apparatus.
CP	Computers	A mechanical or electronic mathematical calculating device.
CR	Crystals	Crystal in crystal holder.
CU	Coupling devices	Impedance coupling devices, directional couplers, etc.
CV	Converters (electrical)	Electronic apparatus for changing the phase, frequency, or amplitude of the signal from one medium to another.
CW	Covers	Cover, bag, roll, cap, radome, nacelle, etc.
CX	Cords	Cord with terminals; also composite cables of RF and non-RF conductors.
CY	Cases	Rigid and semirigid structures for housing or carrying equipment.

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DA	Antenna, dummy	RF test loads.
DT	Detecting heads	Magnetic pickup device, search coil, hydrophone, etc.
DY	Dynamotors	Dunamotor power supply.
E	Hoist assembly	Sonar hoist assembly, etc.
F	Filters	Band-pass, noise, telephone, wave traps, etc.
FN	Furniture	Chairs, desks, tables, etc.
FR	Frequency-measuring devices	Frequency meters, echo boxes, etc.
G	Generators	Electrical power generators without prime movers. (See PU and PD.)

Component indicator	Family name	Examples
GO	Goniometers	Goniometers of all types.
GP	Ground rods	Ground rods, stakes, etc.
H	Head, hand, and chest sets	Includes earphone.
HC	Crystal holder	Crystal holder less crystal.
HD	Air-conditioning apparatus	Heating, cooling, dehumidiflying, pressure, vacuum devices, etc.
ID	Indicating devices	Calibrated dials and meters, indicating lights, etc. (See IP.)
IL	Insulators	Strain, standoff, feedthrough, etc.
IM	Intensity-measuring devices	Includes standing wave ratio (SWR), gear, field intensity and noise meters, etc.
IP	Indicators, cathode-ray tube	Azimuth, elevation, plan position indicator (PPI), panoramic, etc.
J	Junction devices	Junction, jack, and terminal boxes; connector panels, etc.
KY	Keying devices	Mechanical, electrical, and electronic keyers, coders, interrupters, etc.
LC	Tools, line construction	Includes special apparatus, such as cable plow.
LS	Loudspeakers	Separately housed, loudspeakers.
M	Microphones	Radio, telephone, throat, hand, etc.
MD	Modulators	Device for varying amplitude, frequency, or phase.
ME	Meters, portable	Multimeters, volt-ohm-milliammeters, vacuum tube voltmeters, power meters, etc.
MK	Maintenance kits or equipments	Radio, telephone, general utility, etc.
ML	Meteorological devices	Barometer, hygrometer, thermometer, scales, etc.
MT	Mountings	Mountings, racks, frames, stands, etc.
MX	Miscellaneous	Equipment not otherwise classified. (Do not use if better indicator is available.
O	Oscillators	Master frequency, blocking, multivibrators, etc. For test oscillators, see SG.

Component indicator	Family name	Examples
OA	Operating assemblies	Assembly of operating units not otherwise covered.
OC	Oceanographic devices	Bathythermographs, etc.
OS	Oscilloscope, test	Test oscilloscopes for general test purposes.
PD	Prime drivers	Gasoline engines, electric motors, diesel, motors, etc.
PF	Fittings, pole	Cable hanger, clamp, protectors, etc.
PG	Pigeon articles	Container, loft, vest, etc.
PP	Power supplies	Nonrotating machine-type, such as vebrator pack, rectifier, thermoelectric.
PT	Plotting equipments	Except meteorological. Boards, maps, plotting table, etc.
PU	Power equipments	Rotating power equipment (except dynamotors), motor-generator, etc.
R	Receivers	All types of receivers except telephone.
RD	Recorders and reproducers	Tape, facsimile, disk, magnetic, etc.
RE	Relay assemblies	Electrical, electronic, etc.
RF	Radio-frequency component	Composite component of RF circuits (Do not use if better indicator is available.
RG	Cables and transmission line, bulk RF	RF cable, waveguides, etc., without terminals.
RL	Reel assemblies	Antenna, field wire, etc.
RP	Rope and twine	Nonelectrical cord, etc.
RR	Reflectors	Target, confusion, etc,, except antenna reflectors. (See AT.)
RT	Receiver and transmitter	Radio and radar transceivers, composite transmitter and receiver, etc.
S	Shelters	House, tent, protective shelter, etc.
SA	Switching devices	Manual, impact, motor-driven, pressure-operated, etc.
SB	Switchboards	Telephone, fire control, power, panel, etc.
SG	Generators, signal	Includes test oscillators and noise generators. (See O.)
SM	Simulators	Flight, aircraft, target, signal, etc.
SN	Synchronizers	Equipment to coordinate two or more functions.

Component indicator	Family name	Examples
ST	Straps	Harness, straps, etc.
T	Transmitters	All types of transmitters except telephone.
TA	Telephone apparatus	Miscellaneous telephone equipment.
TD	Timing devices	Mechanical and electronic timing devices, range devices, multiplexers, electronic gates, etc.
TF	Transformers	Transformers when used as separate items.
TG	Positioning devices	Tilt or train assemblies.
TH	Telegraph apparatus	Miscellaneous tool assemblies.
TK	Tool kits or equipments	Miscellaneous tool assemblies.
TL	Tools	All types except line construction. (See LC.)
TN	Tuning units	Receiver, transmitter, antenna, etc.
TS	Test equipment	Test and measuring equipment.
TT	Teletypewriter and facsimoe apparatus	Miscellaneous tape, teletype, facsimile equipment, etc.
U	Connectors, audio and power	Unions, plugs, sockets, adapters, etc.
UG	Connectors, RF	Unions, plugs, sockets, choke couplings, adapters, elbows, flanges, etc.
V	Vehicles	Carts, dollies, trucks, trailers, etc.
VS	Signaling equipment, visual	Flag sets, air panels, signal lamp equipment, etc.
WD	Cables, two-conductor	Includes non-RF wire, cable, and cordage in bulk.
WF	Cables, four-conducotr	Includes non-RF wire, cable, and cordage in bulk.
WM	Cables, multiple-conductor	Includes non-RF wire, cable, and cordage in bulk.
WS	Cables, single-conductor	Includes non-RF wire, cable, and cordage in bulk.
WT	Cables, three-conductor	Includes non-RF wire, cable and cordage in bulk.

4-8. CAUSES OF POOR COMMUNICATION

If the equipment is in good condition, poor communication or a lack of communication can be caused by--

a. Too great a distance between sets.

b. Bad terrain--hills and mountains.

c. Poor choice of location at one or both ends of the circuits.

d. Insufficient battery power.

e. Noise and interference.

4-9. OPERATING HINTS

a. When the signal is weak, use a headset of a loudspeaker to cut out local noise.

b. Be sure the microphone or handset is in good condition. Allow a few seconds for the transmitter tubes to warm up after pressing the press-to-talk switch; then speak directly into the microphone. Speak slowly and distinctly.

c. If the set is in a vehicle, be sure the battery voltage is normal. Keep the engine running to charge the battery.

d. Moving the antenna a few feet to a new location may improve reception.

e. Use CW instead of voice for increased range on AM radios.

Notes. ______________________________

CHAPTER 5

LOW-POWER FREQUENCY MODULATED RADIO SETS

5-1. RADIO SETS AN/PRC-77, AN/VRC-64, AND AN/GRC-160

a. General. Radio set AN/PRC-77 (fig 5-1) is a versatile, lightweight, frequency modulated radio set that can be operated from a pack or a vehicle and permits operation with speech security equipment. The AN/PRC-77 uses the RT-841/PRC-77 and is powered by a dry cell battery or by a special vehicular power supply. The basic radio set is known as the AN/PRC-77; however, recent changes in nomenclature make the following distinctions in the use of the receiver-transmitter RT-841/PRC-77.

(1) When used for manpack operation only, the radio is known as the AN/PRC-77.

(2) When used for vehicular operation only, the radio is known as the AN/VRC-64.

(3) When used for manpack or vehicular operation, the radio is known as the AN/GRC-160.

b. Characteristics. The characteristics of radio receiver-transmitter RT-841/PRC-77 are as follows:

(1) Frequency range:

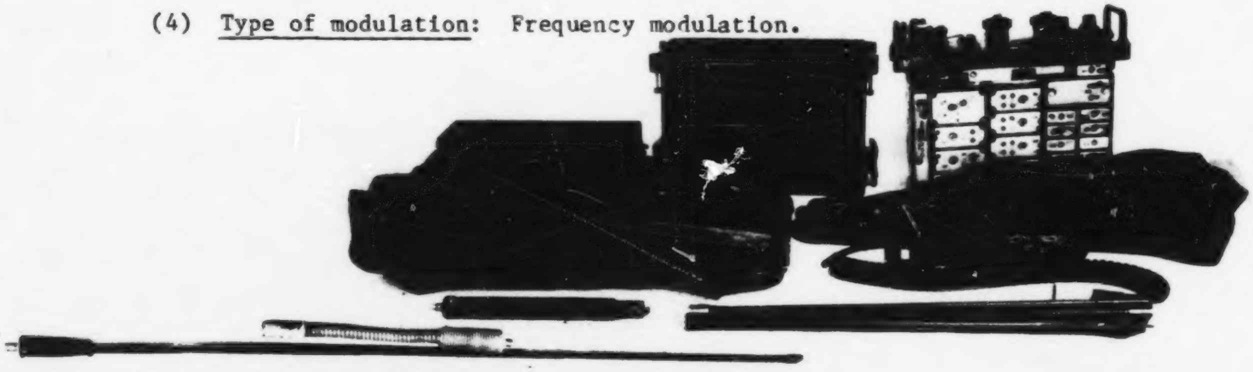
(a) Low band: 30.00 to 52.95 megahertz.

(b) High band: 53.00 to 75.95 megahertz.

(2) Preset channels: Two.

(3) Number of channels: 920.

(4) Type of modulation: Frequency modulation.



Note. Battery is not issued with the radio set AN/PRC-77.

Figure 5-1. Radio set AN/PRC-77.

(5) Type of transmission and reception: Voice.

(6) Transmitter power output: 1.5 to 4.0 watts.

(7) Type of squelch: Tone-operated.

(8) Distance range: 8 kilometers (5 miles).

(9) Type of tuning: Detent.

(10) Antennas:

(a) AN/VRC-64. AT-912/VRC or AS-1729/VRC, center-fed whip.

(b) AN/GRC-160. AT-912/VRC or AS-1729/VRC, center-fed whip; AT-271A/PRC, 10-foot multisection whip; AT-892/PRC-25, 3-foot semirigid tape.

(c) AN/PRC-77. AT-271A/PRC, 10 foot multisection whip; AT-892/PRC-77, 3-foot semirigid tape.

(11) Battery life: The BA-386/U is a standard, carbon, dry-cell battery that will operate approximately 30 hours with the RT-841/PRC-77. The BA-4386/U is a magnesium cell battery that will operate approximately twice as long (60 hrs).

(12) Power supply: Amplifier-power supply group OA-3633/GRC is used with the AN/VRC-64 and AN/GRC-160. Input voltage is 24 volts DC.

5-2. RADIO RECEIVER-TRANSMITTER RT-841/PRC-77.

The receiver-transmitter RT-841/PRC 77 (fig 5-2) is housed in a watertight case and secured with four captive screws. All controls are on the front panel. A radio plug projects from the receiver-transmitter and mates with the connector of the battery. The battery box is part of the receiver-transmitter; it protects and houses the battery. The battery rests on a foam rubber pad fastened to the bottom of the case.

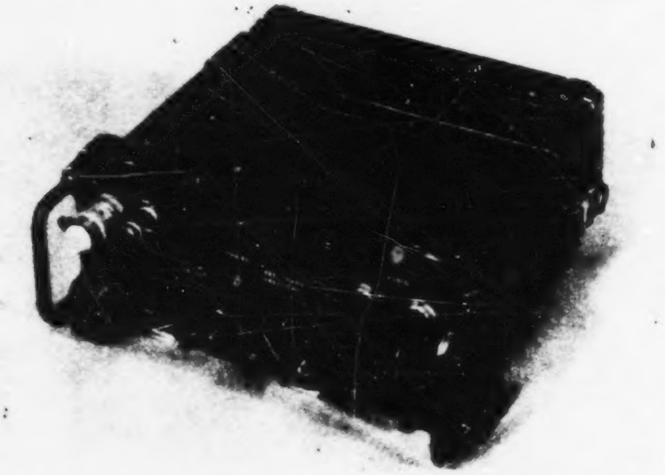


Figure 5-2. Receiver-transmitter RT-841/PRC-77.

5-3. AMPLIFIER-POWER SUPPLY GROUP OA-3633/GRC

a. The amplifier-power supply group OA-3633/GRC (fig 5-3) consists of amplifier-power supply AM-2062/GRC and special-purpose electrical cable assembly CX-4655/U. The CX-4655/U provides for interconnection of the AM-2060/GRC and an installed receiver-transmitter.

b. The AM-2060/GRC is a one-piece, cast-aluminum housing containing an internally mounted plug-in module, operating controls, connectors, and a loudspeaker. All operating controls are on the front of the unit.

c. An access plate, attached with six mounting screws, can be removed to provide access to the internally mounted plug-in module and components. Two mounting clamps at the front of the unit and a mounting plate at the rear attach the AM-2060/GRC to the receiver-transmitter. Two slides allow easy insertion of the receiver-transmitter, and a bumper plate at the rear of the base assembly provides cushioning.

d. A power input connector that distributes power, control, and signal voltages between the OA-3633/GRC and other equipment of the radio set system, an antenna control connector, cable clips for storing the CX-4655/U when not in use, and two guide pinholes to aid in holding the AM-2060/GRC to the mounting MT-1029/VRC are located on the rear of the unit.

e. For a description of mounting MT-1029/VRC, see paragraph 6-4.

f. For a description of antenna AT-912/VRC, see paragraph 6-5; and for a description of antenna AS-1729/VRC, see paragraph 6-6.

g. For a discussion of vehicular installation, see TM 11-5820-498-10.

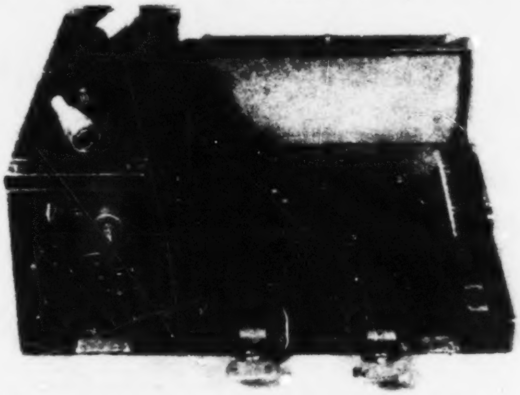


Figure 5-3. Amplifier-power supply group OA-3633/GRC.

5-4. OPERATING PROCEDURE FOR RADIO SET AN/PRC-77.

a. Set the function switch to ON.

b. Set the BAND switch to 30-52 or 53-75, depending on the channel to be used.

c. Turn the MC and KC tuning controls so that the desired channel appears in the channel dial.

d. Set the VOLUME control to 4; readjust for a desired sound level in the handset H-138/U H-189 or H-250.

e. Set the function switch to SQUELCH to eliminate rushing noise when no signal is being received.

f. To transmit, press the PUSH-TO-TALK switch and speak into the H-138/U.

g. To receive, release the PUSH-TO-TALK switch.

h. To shut down the equipment, set the function switch to OFF.

Note. Do not speak into both elements of the H-138/U. The H-138/U has two microphone elements for noise cancellation; speaking into both elements simultaneously will cancel out your voice.

5-5. RADIO SET AN/VRC-64

The AN/VRC-64 (fig 5-4) is a vehicular radio using the same receiver transmitter as the AN/PRC-77. It is to be used in vehicles in which one-channel communications of limited range is required.

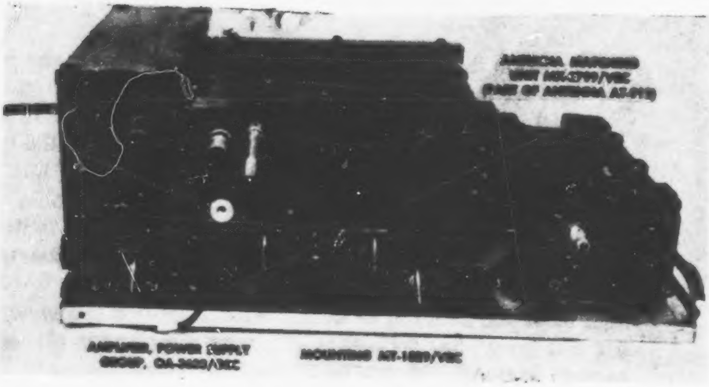


Figure 5-4. Radio set AN/VRC-64.

5-6. OPERATING PROCEDURE FOR RADIO SET AN/VRC-64

a. Turn the receiver-transmitter function switch to ON.

b. Turn the AM-2060/GRC PWR switch to ON.

c. Connect the handset to either of the two AUDIO connectors.

d. Adjust the receiver-transmitter VOLUME control until background noise is heard.

e. If squelch operation is to be used, turn the function switch to SQUELCH.

f. If the AM-2060/GRC loudspeaker is to be used--

(1) Set the SPKR switch to ON.

(2) Adjust the VOLUME control to a desired listening level.

g. Tune the receiver-transmitter as follows:

(1) Turn the BAND switch to 30-52 or 53-75, according to the frequency band desired.

(2) Turn the MC and KC tuning controls until the operating frequency appears on the channel dial.

h. Turn the AM-2060/GRC ANT FREQ CONTROL to the position that includes the selected operating frequency.

i. To transmit, press the PUSH-TO-TALK switch and speak into one microphone element; to listen, release the switch.

j. To turn off the radio set--

(1) Set the AM-2060/GRC PWR switch to OFF.

(2) Turn the receiver-transmitter function switch to OFF.

5-7. RADIO SET AN/GRC-160

The AN/GRC-160 (fig 5-5) radio set incorporates the components, operational facilities, and characteristics of the portable radio set AN/PRC-77 (fig 5-1) and the vehicular radio set AN/VRC-64 (fig 5-4) and can be operated as either a portable or vehicular radio. It weights approximately 84 pounds in the vehicular configuration.

Note. When removing this radio from a vehicle to use it as a portable, set, insure that the dummy connector plug is connected to the power connector on the receiver-transmitter. The power from the battery BA-4386 must pass through this dummy connector plug to power the receiver-transmitter.

5-8. RADIO RECEIVER AN/PRR-9 AND RADIO TRANSMITTER AN/PRT-4 (SQUAD RADIO)

a. The radio receiver AN/PRR-9 (fig 5-6) is a portable, frequency modulated, crystal-controlled radio receiver designed to be worn on a standard combat helmet, clipped to a harness, or carried in a shirt pocket. A lanyard is used as a retainer to prevent loss. The AN/PRR-9 receives voice and tone-modulated signals on a preset channel in the frequency band of 47.0 to 57.0 megahertz. The frequency is determined by the crystal installed in the receiver.

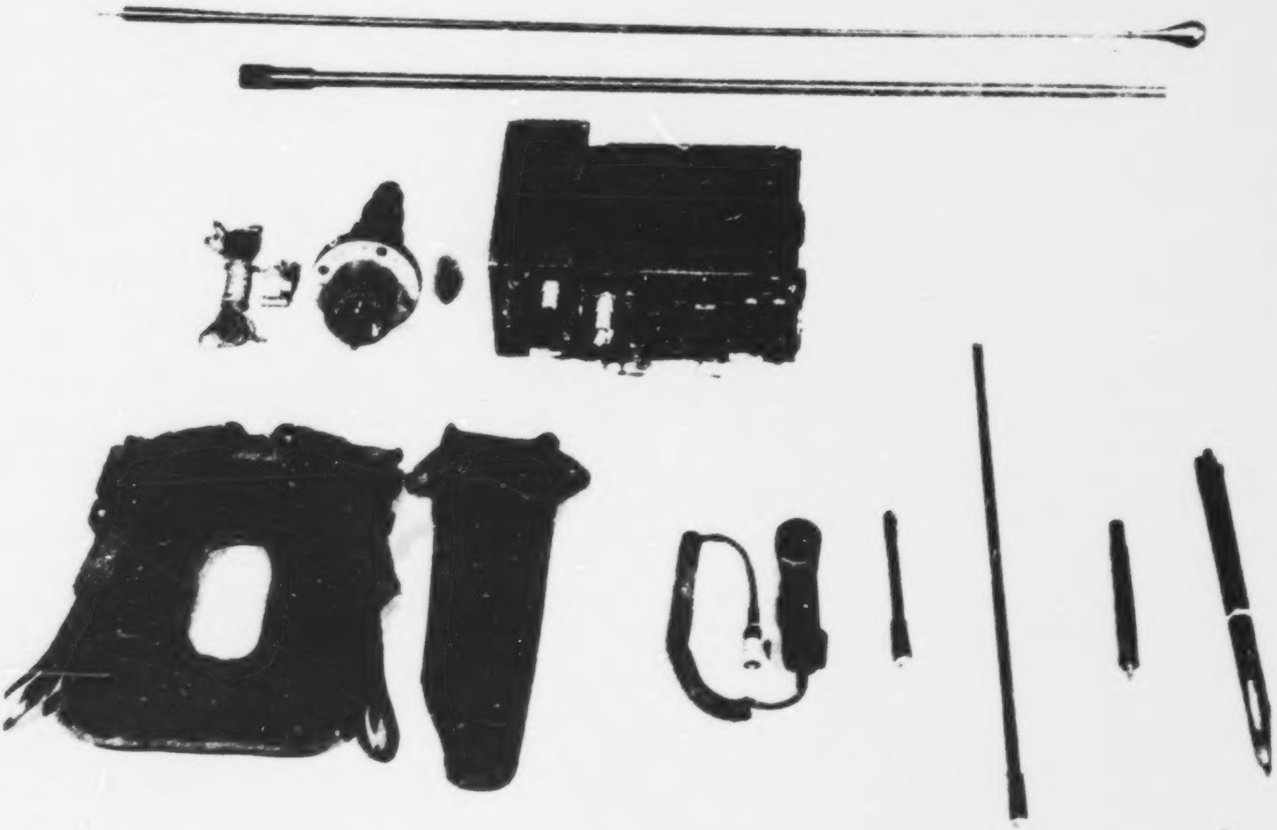


Figure 5-5. Radio set AN/GRC-160.

An audio transducer is attached to the side of the receiver and directs sound under the rim of the helmet toward the operator's ear. Also supplied is an earphone that plugs into the receiver jack, automatically disconnecting the horn. The receiver will be shipped and supplied with a crystal for a channel frequency of 51.0 megahertz. The frequency marking on the crystal is 10.7 megahertz below the channel frequency. The channel frequency of 51.0 megahertz uses a crystal with a frequency marking of 40.30 megahertz.

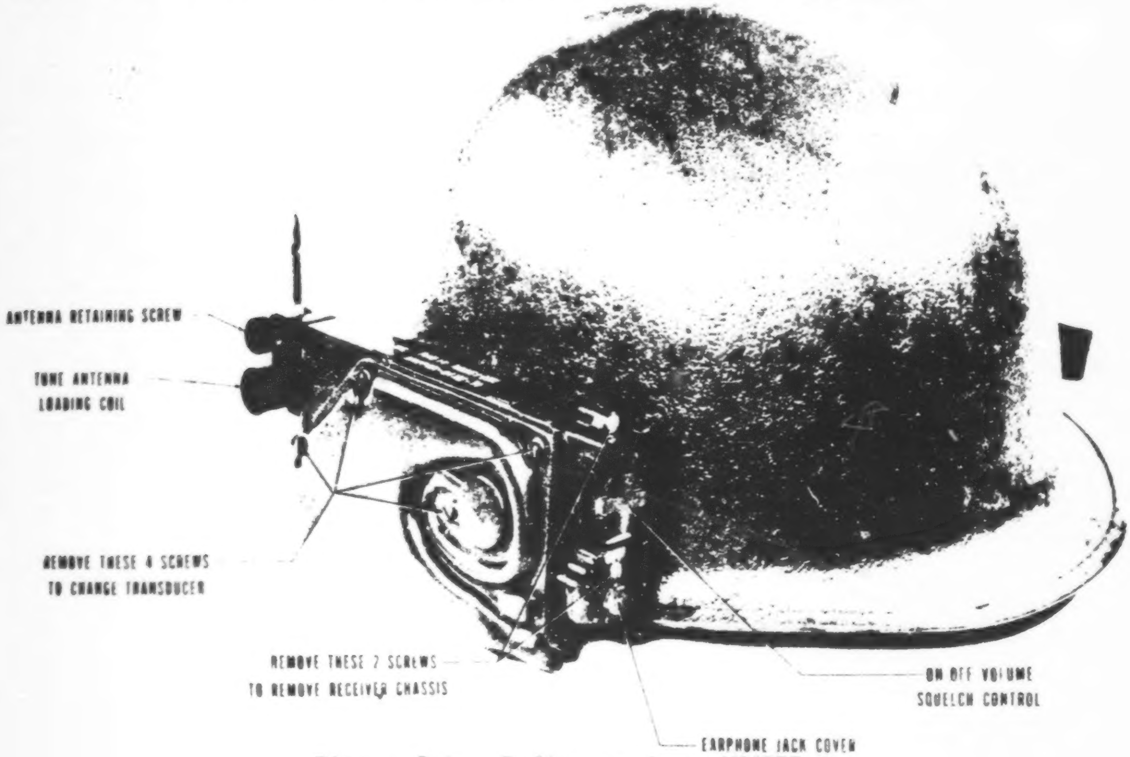

ANTENNA RETAINING SCREW
TUNE ANTENNA LOADING COIL
REMOVE THESE 4 SCREWS TO CHANGE TRANSDUCER
REMOVE THESE 2 SCREWS TO REMOVE RECEIVER CHASSIS
ON OFF VOLUME SQUELCH CONTROL
EARPHONE JACK COVER

Figure 5-6. Radio receiver AN/PRR-9.

(1) Characteristics of radio receiver AN/PRR-9.

(a) Frequency range: 47.0 to 57.0 megahertz.

(b) Tuning: Single-channel, crystal-controlled.

(c) Crystal marking: In megahertz, 10.7 MHz below channel frequency.

(d) Power source: Battery BA-505/PRR-9.

(e) Antenna: Stainless steel whip, 18 inches long.

(f) Channels: 100 possible. (The set is issued with a 51.0-megahertz crystal installed.)

(g) Weight: 10 ounces, including battery, lanyard, and earphone.

(2) Control and operation.

(a) On-off-volume-squelch control. When this control is in the maximum counterclockwise position, radio receiver power is turned off. Turned clockwise, the control turns on the set and adjusts volume for squelch operation. In the maximum clockwise position, the control deactivates the squelch circuit. Volume can still be adjusted by rotating the control. If squelch is to be reactivated, the control must be turned all the way off then back on to the proper volume level.

(b) Antenna retaining screw. This screw permits adjustment of the antenna to one of two positions that are 90° apart.

b. The radio transmitter AN/PRT-4 (fig 5-7) is a handheld, dual-channel, crystal-controlled, frequency modulated transmitter designed for use in the 47.0 to 57.0 megahertz band. It transmits an audio tone or voice communication on either of two channels. The frequencies of operation are determined by the crystals installed in the transmitter. The two channels may be separated by as much as 1 MHz in frequency within the 47.0- to 57.0-megahertz band.

(1) Characteristics of radio transmitter AN/PRT-4.

(a) Frequency range: 47.0 to 57.0 megahertz.

(b) Tuning: Dual-channel controlled.

(c) Crystal marking: In megahertz, 10.7 MHz below channel frequency.

(d) Power source: Battery BA-399/PRT-4.

(e) Antenna: Telescopic whip, 24 inches long.

(f) Channels: 100 possible. (The set is issued with a 51.0-megahertz crystal installed).

(g) Types of signal: Voice or internally generated 1,200-hertz warbling tone.

(h) Planning range: Channel 1, 1 mile (1.6 km); channel 2, 0.5 mile (0.8 km).

(i) Weight: 18 ounces including battery and lanyard.

(2) Controls and operation.

(a) CH-1--CH-2 switch. This is used for selecting channel 1 or channel 2.

(b) TONE-VOICE switch.

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1. When this switch is in the center position, transmitter power is turned off.

2. When this switch is turned clockwise to the maximum extent, transmitter power is turned on and a 1,200-hertz tone is generated to modulate the RF carrier frequency.

3. When this switch is turned counterclockwise to the maximum extent, transmitter power is turned on and the operator talks into the microphone for voice modulation.

Note. This is a spring-loaded switch and must be held in the TONE or voice position for operation.

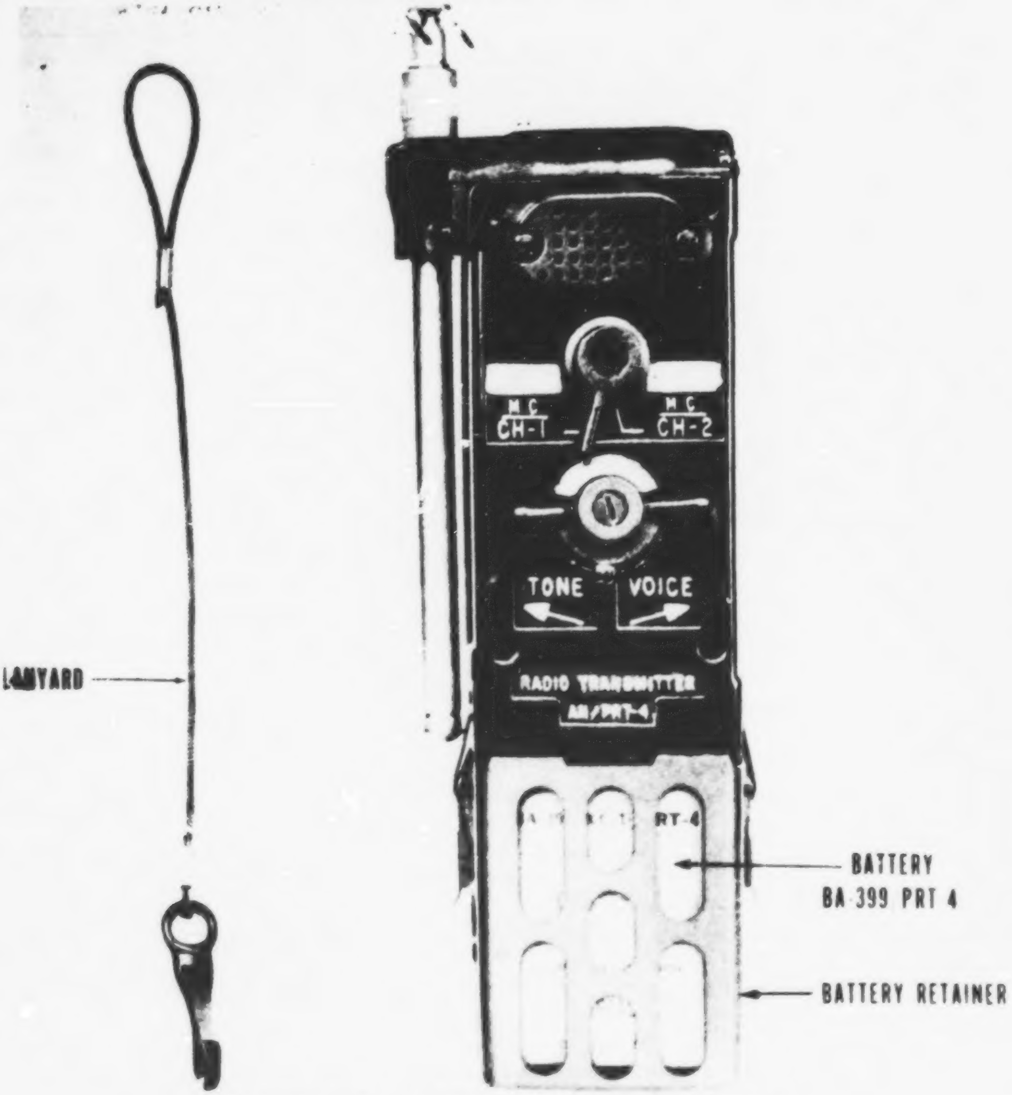

LANYARD
MC CH-1
MC CH-2
TONE
VOICE
RADIO TRANSMITTER AN/PRT-4
PRT-4
BATTERY BA 399 PRT 4
BATTERY RETAINER

Figure 5-7. Radio transmitter AN/PRT-4.

Notes.

CHAPTER 6

FREQUENCY MODULATED RADIO EQUIPMENT

Section I. MEDIUM-POWER SETS

6-1. RADIO-SETS AN/VRC-12 AND AN/VRC-43 THROUGH AN/VRC-49

a. Radio sets AN/VRC-12 and AN/VRC-43 through AN/VRC-49, commonly referred to as the AN/VRC-12 series radios (fig 6-1), are the most commonly used radio sets in the army. All configurations of these radio sets consist of various combinations of two basic components-- a receiver-transmitter and an auxiliary receiver. There are two versions of the receiver-transmitter-- one with 10 pushbottons for presetting channels (RT-246/VRC) and one with a built-in loudspeaker (RT-524/VRC). The receiver-transmitter with the pushbuttons was designed for use in tracked vehicles in which the control panel is generally inaccessible to the operator and noise from the vehicle would require the use of a headset. The receiver-transmitter with the built-in loudspeaker is used in wheeled vehicles in which the operator has easy access to the control panel and the noise level permits monitoring with a loudspeaker. The auxiliary receiver R-442/VRC is manually tuned and can be used in both tracked and wheeled vehicles with the addition of a headset or an external loudspeaker. All configurations of radios of the AN/VRC-12 series have as a component one antenna AS-1729/VRC.

b. Radio set AN/VRC-12 consists of one RT-246/VRC operating on one frequency and one R-442/VRC operating on another frequency.

c. Radio set AN/VRC-43 consists of one RT-246/VRC operating on one frequency.

d. Radio set AN/VRC-44 consists of one RT-246/VRC operating on one frequency and two R-442/VRC's operating on a different frequency.

e. Radio set AN/VRC-45 consists of two RT-246's each operating on a different frequency.
The AN/VRC-45 provides an automatic retransmission facility.

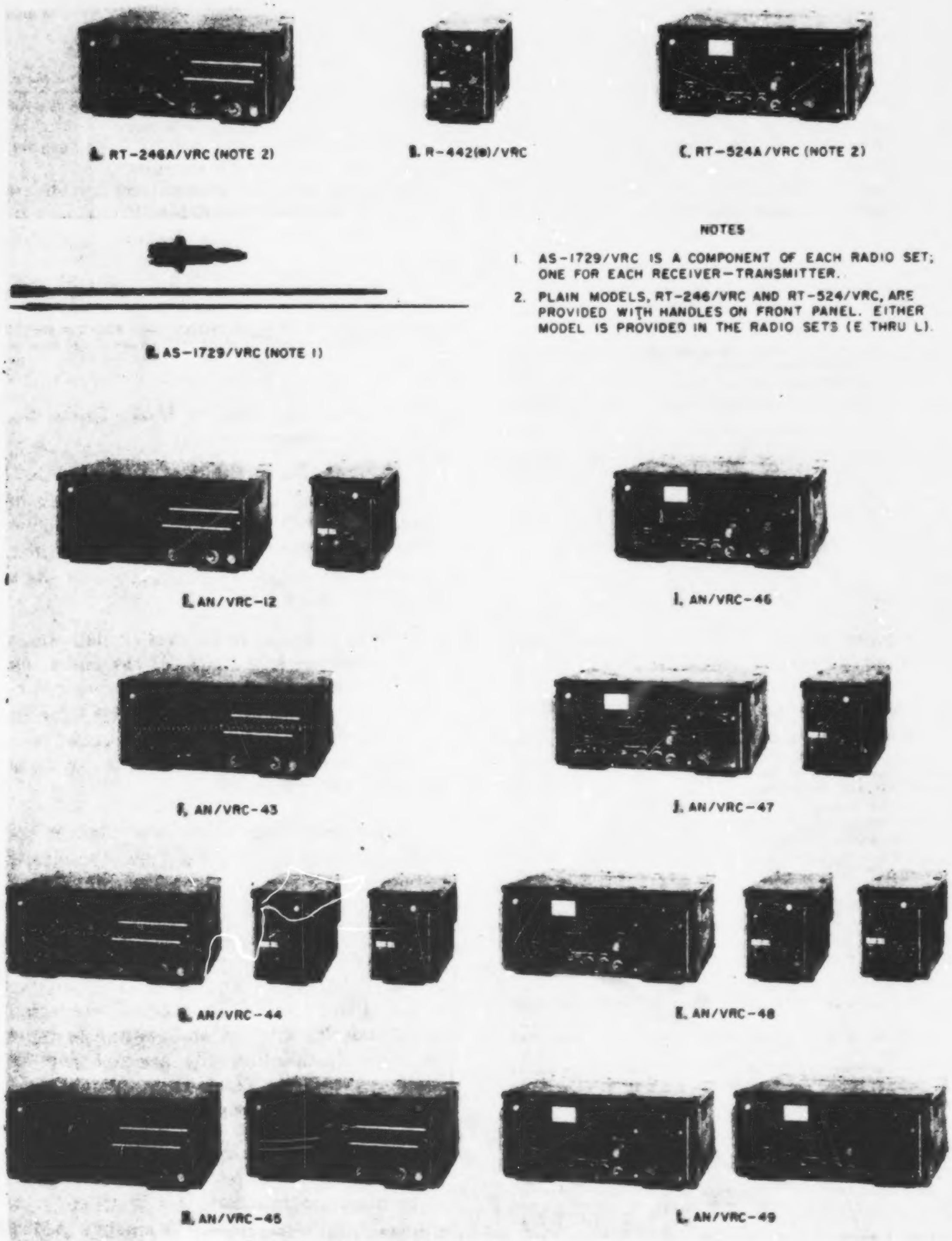
f. Radio set AN/VRC-46 consists of one RT-524/VRC operating on one frequency.

g. Radio set AN/VRC-47 consists of one RT-524/VRC operating on one freauency and one R-442/VRC operating on a different frequency.

i. Radio set AN/VRC-49 consists of two RT-524/VRC's each operating on a different frequency. The AN/VRC-49 provides an automatic retransmission facility.

6-2. RADIO RECEIVER R442/VRC AND RADIO RECEIVER-TRANSMITTERS RT-246/VRC AND RT-524/VRC

a. General. The R-442/VRC, RT-246/VRC (fig 6-2), and RT-524/VRC (fig 6-3) are rugged, lightweight, compact units housed in watertight cases. All the operating controls are located on the front panel. The hinged cover on the RT-246/VRC provides access for making presitting adjustments and is held in place by two captive screws in front of the pushbutton assembly. On each of the three units a connector at the rear mates with a connector on the front of the junction box on the mount. Two guide pinholes are recessed for the guide pins on the mounts. A blower inside each receiver-transmitter case aids in dissipating heat. The top and bottom covers are held in place by captive screws.



A. RT-246A/VRC (NOTE 2)

B. R-442(*)/VRC

C. RT-524A/VRC (NOTE 2)

D. AS-1729/VRC (NOTE 1)

NOTES

1. AS-1729/VRC IS A COMPONENT OF EACH RADIO SET; ONE FOR EACH RECEIVER-TRANSMITTER.
2. PLAIN MODELS, RT-246/VRC AND RT-524/VRC, ARE PROVIDED WITH HANDLES ON FRONT PANEL. EITHER MODEL IS PROVIDED IN THE RADIO SETS (E THRU L).

E. AN/VRC-12

I. AN/VRC-46

F. AN/VRC-43

J. AN/VRC-47

G. AN/VRC-44

K. AN/VRC-48

H. AN/VRC-45

L. AN/VRC-49

Figure 6-1. AN/VRC-12 series radios.

b. Characteristics of receiver-transmitters RT-246/VRC and RT-524/VRC.

(1) General.

(a) Type of modulation: Frequency modulation.

(b) Tuning facility: Manual tuning. In RT-246/VRC, 10 frequencies can be set up for automatic pushbotton tuning.

(c) Control of matching networks in antenna: Tuning the receiver-transmitter also automatically selects proper matching networks in the antenna.

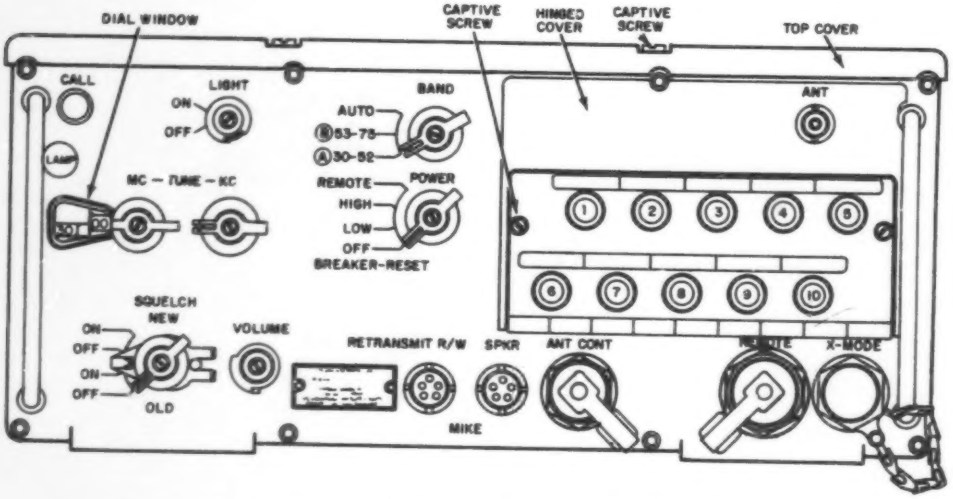

DIAL WINDOW
CAPTIVE SCREW
HINGED COVER
CAPTIVE SCREW
TOP COVER
CALL
LAMP
LIGHT
ON
OFF
BAND
AUTO
Ⓑ53-75
Ⓐ30-52
ANT
MC — TUNE — KC
REMOTE
POWER
HIGH
LOW
OFF
BREAKER-RESET
1
2
3
4
5
6
7
8
9
10
SQUELCH
NEW
ON
OFF
ON
OFF
OLD
VOLUME
RETRANSMIT R/W
SPKR
ANT CONT
REMOTE
X-MODE
MIKE

Figure 6-2. Receiver-transmitter RT-246/VRC.

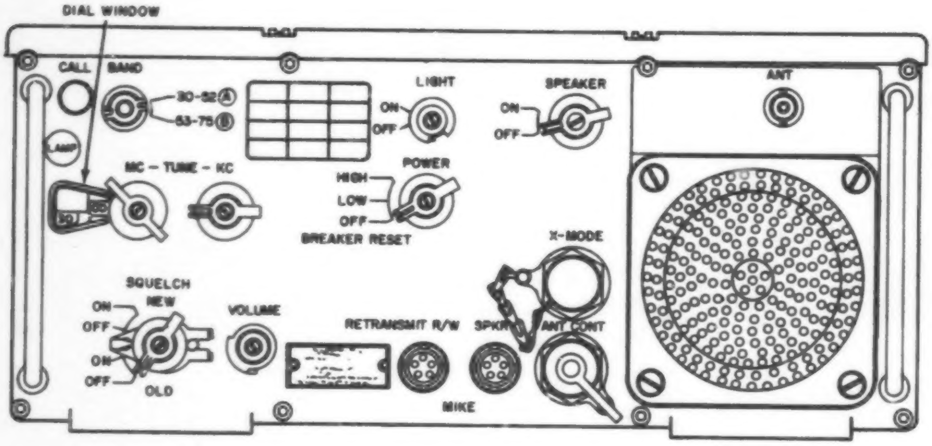

DIAL WINDOW
CALL
BAND
30-52Ⓐ
53-75Ⓑ
LIGHT
ON
OFF
SPEAKER
ON
OFF
ANT
LAMP
MC — TUNE — KC
POWER
HIGH
LOW
OFF
BREAKER RESET
X-MODE
SQUELCH
NEW
ON
OFF
ON
OFF
OLD
VOLUME
RETRANSMIT R/W
SPKR
ANT CONT
MIKE

Figure 6-3. Receiver-transmitter RT-524/VRC control panel.

(d) Operating conditions: Push-to-talk and release-to-listen.

(e) X-mode: Provides facilities for secure voice operations.

(2) Transmitting features.

(a) Output power:

1. Low power: 0.5 to 8 watts.

2. High power: 35 watts minimum.

(b) Transmission distance:

1. Low power: 8 km.

2. High power: 40 km.

(c) Squelch tone signal: 150 Hz transmitted in all settings of SQUELCH switch except OLD ON.

(d) Power drain:

1. Using low power: 3 amperes at 25 volts DC.

2. Using high power: 10 amperes at 25 volts DC.

(3) Receiving functions.

(a) Squelch types:

1. Carrier (operative in OLD SQUELCH): Responsive to carrier noise.

2. Tone (operative in NEW SQUELCH): Responsive to 150-Hz tone signal.

(b) Power drain: 0.75 ampere at 25 volts DC.

(4) Additional characteristics: See table 6-1.

c. Characteristics of receiver R-442/VRC. See b (1) and (3) above.

d. Operating procedure for receiver R-442/VRC and receiver-transmitters RT-246/VRC.

(1) Turn the SQUELCH switch to OFF.

(2) If operating under blackout conditions, turn the LIGHT switch to OFF; if not under blackout conditions, turn it to ON.

(3) Set the POWER switch on the R-442/VRC to ON-RESET. On the RT-246/VRC or RT-524/VRC, turn the POWER switch to the LOW or HIGH position.

(4) Connect appropriate audio accessories to each unit. On the RT-524/VRC, turn the SPEAKER switch to ON.

(5) Adjust the VOLUME control until background noise is heard.

(6) If squelch is to be used, turn the SQUELCH switch to OLD ON for carrier-operated squelch or to NEW ON for tone-operated squelch.

Note: The position of this switch is governed by the unit's standing operating procedure.

(7) If manual tuning is to be used--

(a) Turn the BAND switch to A to B depending on the channel desired .

(b) Turn the MHz-TUNE and KHz-TUNE knobs until the desired channel appears on the channel dial.

(8) If RT-246/VRC is to be tuned by pushbotton tuning, make the following adjustments.

(a) Turn the BAND switch to AUTO.

(b) Push in the pushbutton for the desired channel.

(c) Set the BAND selector switch for the desired preset to A or B, depending on which band includes the assigned frequency.

(d) Push in and hold the TUNE bottom.

(e) Adjust the preset control (above or below the channel button) until the desired frequency appears in the dial window.

(f) Release the TUNE button.

(g) Check the preceding adjustments by pushing in another button and then push the preset button. The preset frequency should appear in the dial window. If the correct frequency does not appear or if a red mark appears in the dial window, proceed as follows:

1. Turn the BAND switch from AUTO to B.

2. Turn the MHz-TUNE KHz knobs several clicks in either direction.

3. Turn the BAND switch to AUTO and press the preset channel. If the correct frequency does not appear in the dial, window, higher echelon maintenance is required and the frequency will have to be set manually.

(9) If the LIGHT and SQUELCH switches are on, observe the SQUELCH CALL indicator for a visual indication of an incoming signal.

(10) Adjust the VOLUME control for the desired receiver volume.

(11) To transmit over the RT-246/VRC or RT-524/VRC, press the PRESS TO TALK switch and speak into the microphone.

(12) A complete loss of power may result from a tripped circuit breaker. To reset the circuit breaker on the R-442/VRC, set the POWER switch to ON-RESET. To reset the circuit breaker on the RT-246/VRC and RT-524/VRC, turn the POWER switch to OFF BREAKER-RESET and then to LOW or HIGH.

CAUTION: If the circuit breaker trips after being reset, do not reset it again. Notify qualified maintenance personnel.

(13) To deactivate the R-442/VRC, RT-246/VRC, or RT-524/VRC, turn the POWER switch to OFF.

Notes. ______________________________

Notes.

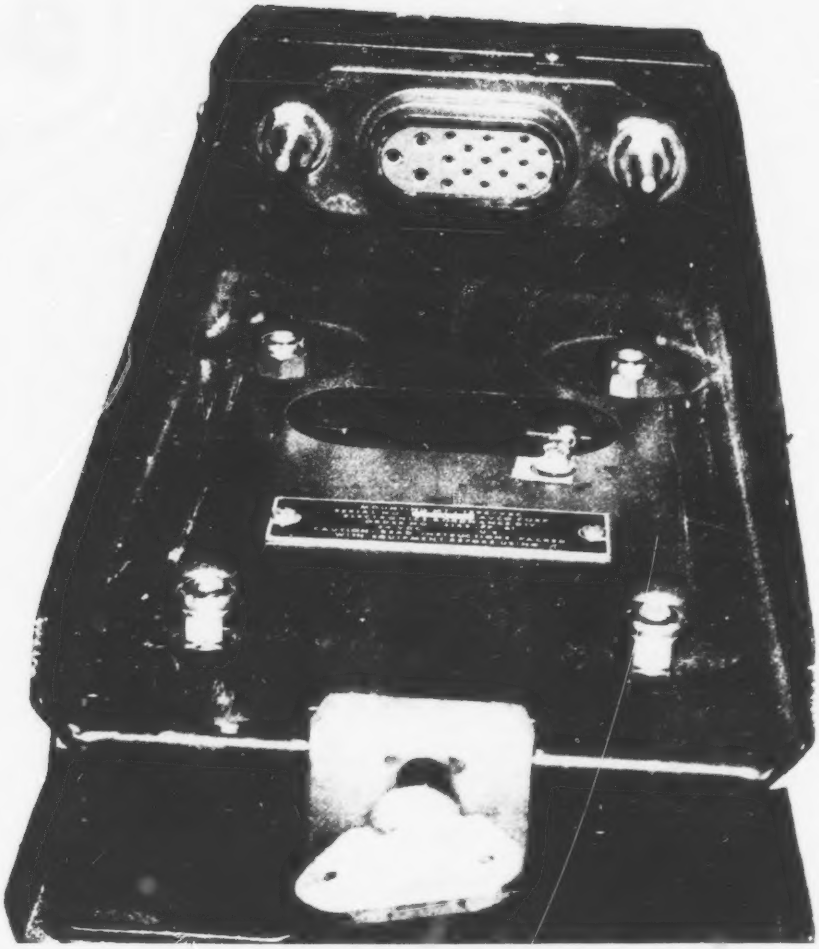


Figure 6-4. Mounting MT-1898/VRC.

6-3. MOUNTING MT-1898/VRC

a. Mounting MT-1898/VRC (fig 6-4) is the mounting for radio receiver R-442/VRC. Four shock isolators, formed of stainless steel mesh, act as the shock abosorbers. Four screws inserted through the shock isolators hold the top tray to the mounting plate. A copper bonding strap connected between the top tray and the mounting plate insures a good ground connection. A clamp locks the R-442/VRC to the top tray. Two guide pins aid in holding the R-442/VRC to the mounting.

b. The MT-1898/VRC contains a gasket-sealed junction box that distributes power, control, and signal voltage between the R-442/VRC and other equipment in the radio set system. The connector on the front of the junction box mates with a connector at the rear of the R-442/VRC. Three additional connectors (not shown), located on the bottom of the junction box, connect the system power and control cables. The junction box also contains a 100-ampere fuse for protection of the vehicle electrical system.

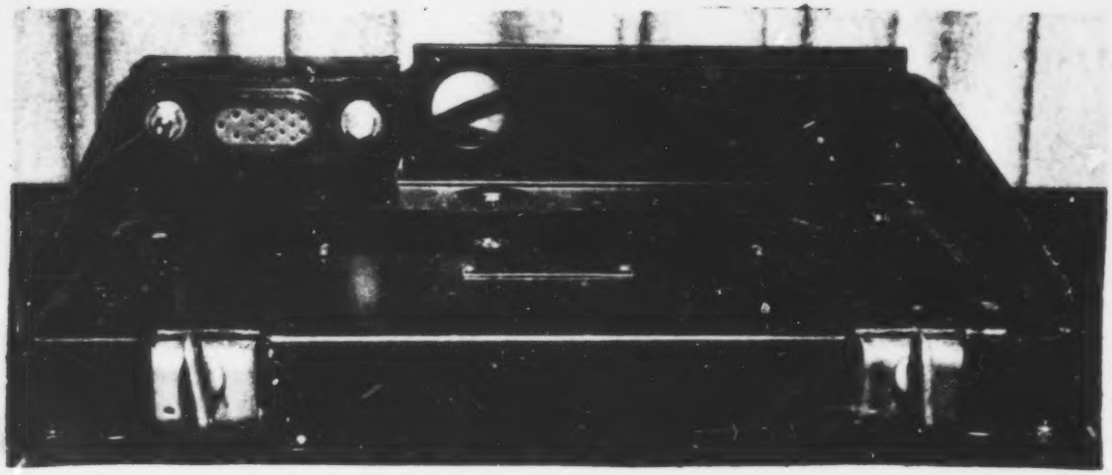

SupR
80170

Figure 6-5. Mounting MT-1029/VRC.

6-4. MOUNTING MT-1029/VRC

a. Mounting MT-1029/VRC (fig 6-5) is the mounting for receiver-transmitter RT-246/VRC, and RT-524/VRC and for amplifier-power supply AM-2060. Five shock isolators, formed of stainless steel mesh, act as the shock absorbers. Five screws inserted through the shock isolators hold the top tray to the mounting plate (lower portion). Two copper bonding straps connected between the top tray and mounting plate insure a good ground connection. Two clamps lock the receiver-transmitter to the mounting.

b. The MT-1029/VRC contains a gasket-sealed junction box that distributes power, control, and signal voltages between the receiver-transmitter and other equipment in the radio set system. The junction box contains a 100-ampere fuse for protection of the vehicle electrical system. The connector on the front of the junction box mates with a connector at the rear of the receiver-transmitter. Three additional connectors (not shown), located on the bottom of the junction box, connect the system power and control cables.

6-5. ANTENNA AT-912/VRC

a. The antenna AT-912/VRC (fig 6-6) is used with receiver-transmitters RT-246/VRC and RT-524/VRC. It consists of a base antenna support AB-719/VRC, antenna elements AT-1095 and AT-1096, and antenna matching unit MX-2799/VRC. The antenna assembly can be installed on any type of wheeled or tracked vehicle with the appropriate installation kit issued for that particular type of vehicle. The antenna is approximately 10 feet long and weighs about 20 pounds. A steel spring assembly permits the antenna to bend without breaking when it strikes an obstruction.

b. Two cables are required for installing the antenna system. Cable assembly CX-4722/U is attached to the ANT CONT receptacle on the receiver-transmitter and to a similar receptacle on the MX-2799/VRC. This cable conducts dc power to the matching unit for automatic matching of the antenna length to the operating frequency. The second cable, CG-1773/U, is connected to the ANT receptable on the receiver-transmitter and to a similar connector on the matching unit. It provides the electrical path for radiofrequency (RF) current from the receiver-transmitter to the antenna itself.

78

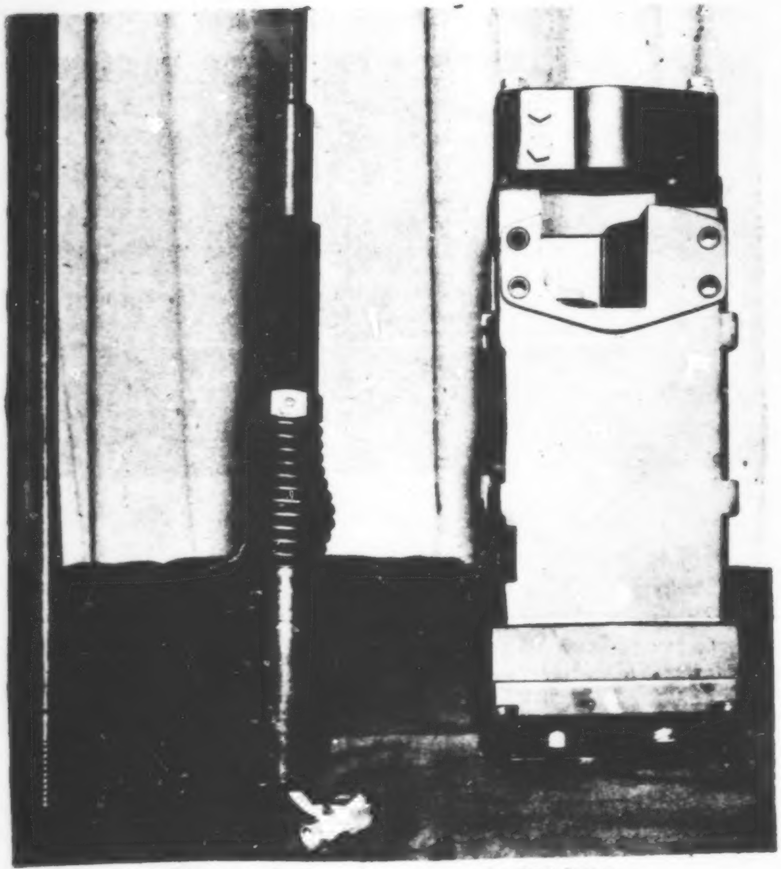


Figure 6-6. Antenna AT-912/VRC.

6-6. ANTENNA AS-1729/VRC

a. Antenna AS-1729/VRC (fig 6-7) was designed to replace antenna AT-912/VRC. The AS-1729/VRC is smaller and lighter than the AT-912/VRC and permits either manual or automatic tuning of the antenna matching unit. The AS-1729/VRC consists of base antenna support AB-719/VRC, antenna matching unit MX-6707, and antenna elements AS-1730/VRC and AS-1095/VRC. The antenna assembly can be installed on any type of wheeled or tracked vehicle with the appropriate installation kit issued for that particular type of vehicle. A spring assembly allows the antenna to bend without breaking when it strikes an obstruction.

b. Two cables are required for installation of the antenna system for automatic matching unit tuning. Cable assembly CS-4722/U is attached to the ANT CONT receptacle on the receiver-transmitter and to a similar receptacle on the MX-6707. This cable conducts DC power to the matching unit for automatic matching of the antenna length to the operating frequency. The second cable, CG-1773/U, provides the radiofrequency band current path from the receiver-transmitter to the base of the antenna. A frequency band selector switch is mounted in the base of the antenna matching unit to allow manual tuning of the frequency band when cable assembly CX-4722/U is not installed.

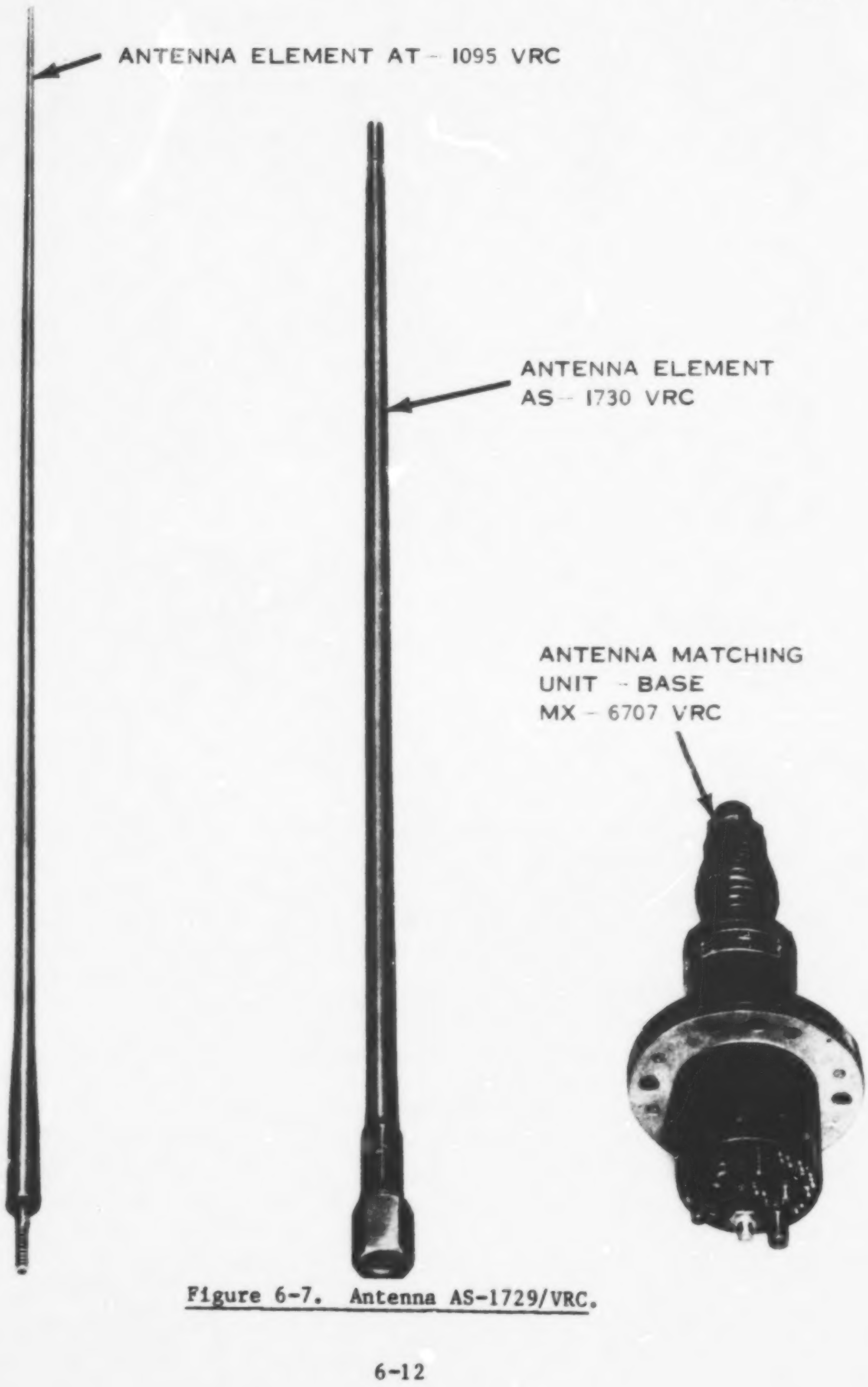

ANTENNA ELEMENT AT- 1095 VRC
ANTENNA ELEMENT AS- 1730 VRC
ANTENNA MATCHING UNIT - BASE MX - 6707 VRC

Figure 6-7. Antenna AS-1729/VRC.

6-7. RECEIVER ANTENNA

The antenna for receiver R-442/VRC consists of mast base AB-15/GR for wheeled vehicles or mast base AB-558/GR for tracked vehicles; mast sections MS-116A, MS-117A, and MS-118A; and adapter UG-237/U. The mast base is mounted on the outside of a vehicle and the mast sections make up a whip antenna that is screwed into the mast base.

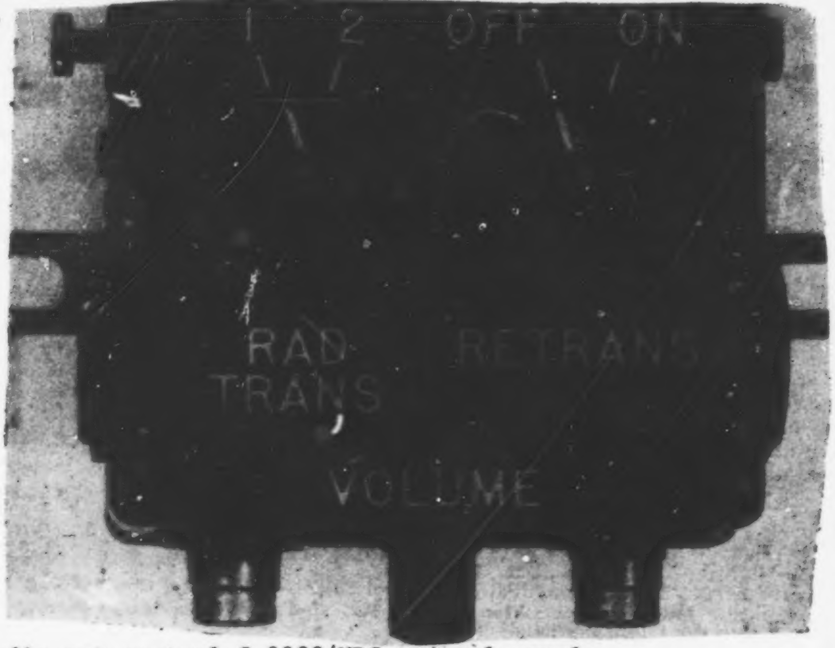


Figure 6-8. Radio set control C-2299/VRC control panel.

6-8. RADIO SET CONTROL C-2299/VRC

a. General. The C-2299/VRC (fig 6-8) is a control box that provides connections between two receiver-transmitters and the audio accessories of certain radios. It also controls automatic retransmission with these radio sets. All operating controls and connectors are external. Audio receptacles and the VOLUME control are located on the bottom of the control set.

b. Operation.

(1) To operate a radio set from the C-2299, perform the steps described in (a) through (d) below.

(a) Turn the RETRANS switch to OFF.

(b) Turn the RAD TRANS switch to the 1 position for the first receiver-transmitter or to the 2 position for the second receiver-transmitter.

(c) Adjust the VOLUME control for the desired volume in the audio accessory.

(d) Press the PUSH-TO-TALK switch and speak into the microphone.

(2) To accomplish automatic retransmission between two distant stations, perform the steps described in (a) through (d) below.

Note. The frequencies used for retransmission must be at least 10 megahertz apart and must be such that the transmitter of either receiver-transmitter will not interfere with the receiver of the other (TM 11-5820-401-12).

(a) Contact each of the distant radio sets and notify the operators that retransmission is being established.

(b) Turn the RETRANS switch to ON.

(c) Monitor the two channels being used through an audio accessory at either audio receptacle on the control box by turning teh RAD TRANS switch to 1 or 2.

(d) At the end of automatic retransmission, turn the RETRANS switch to OFF.

Section II. ANCILLARY EQUIPMENT

6-9. RADIO SET CONTROL GROUP AN/GRA-39 (B)

Radio set control group AN/GRA-39 (B) (fig 6-9 and 6-10) is used with radio sets AN/VRC-12, AN/VRC-43 through 49, AN/PRC-77, AN/VRC-64, AN/GRC-160, and other similar tactical radio sets. The AN/GRA-39 (B) allows voice transmission or reception through a radio set from a maximum distance of 3.2 kn over field wire WD-1/TT. Voice transmission or reception through the radio set is established from either the C-2328 B GRA-39 (B) (remote control unit) or C-2329 B GRA-39 (B) (local control unit) at the option of the operator. Provision is also made for voice communication between the local and remote operators.

a. Characteristics.

(1) Radio set control C-2328 B/GRA-39 (B) (remote control unit).

(a) Number of transistors: Seven.

(b) Control distance (max): 3.2 km (2 miles).

(c) Operating voltage: 9.0 to 6.6 volts DC.

(d) Power supply: Six batteries BA-30.

(e) Battery life expectancy: 24 hours.

(f) Tone generator frequency: 3,900 hertz.

(2) Radio set control C-2329 B/GRA-39 (B) (local control unit).

(a) Number of transistors: Five.

(b) Operating voltage: 9.0 to 6.6 volts DC.

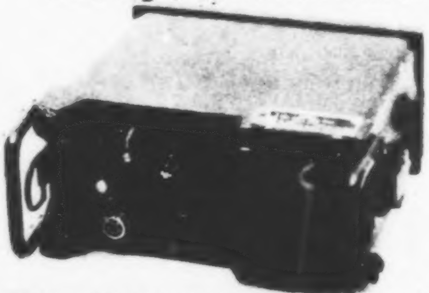
(c) Power supply: Six batteries BA-30.

(d) Battery life expectancy: 72 hours.

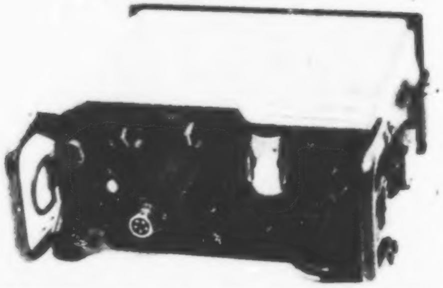
SLING, CARRYING BAG
AND CASE.

BAG, COTTON DUCK CW-589/GRA-39

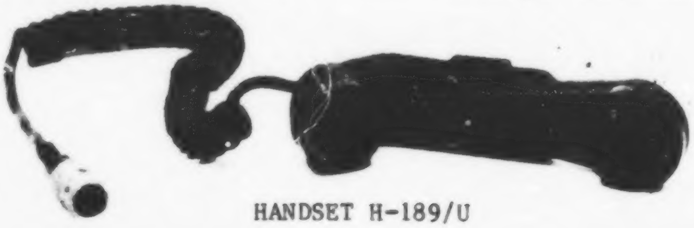
AUXILIARY SLING



CONTROL, RADIO SET C-2328B/GRA-39

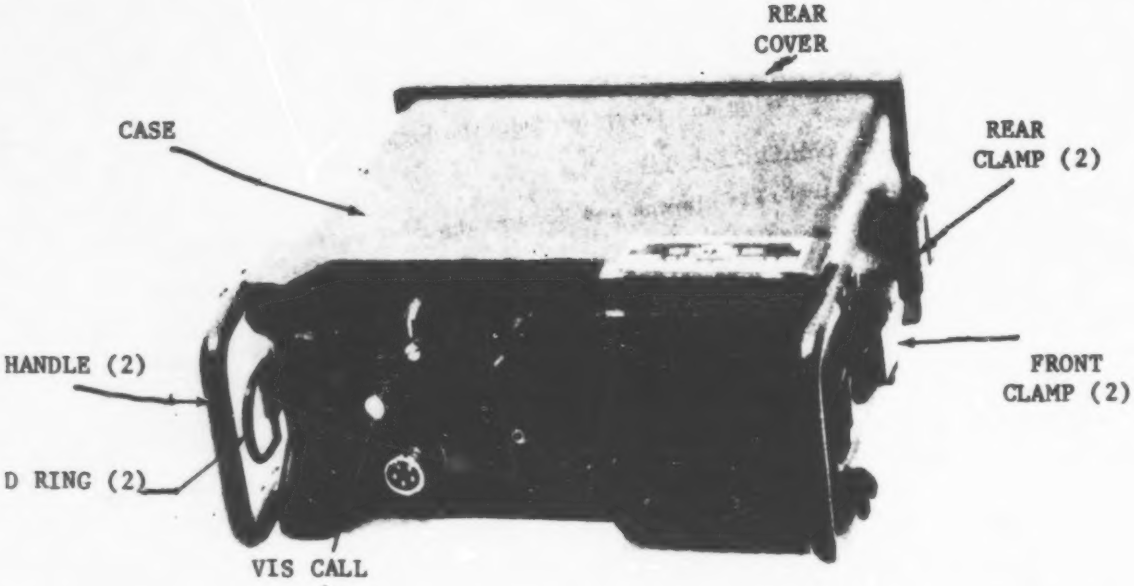


CONTROL, RADIO SET C-2329B/GRA-39

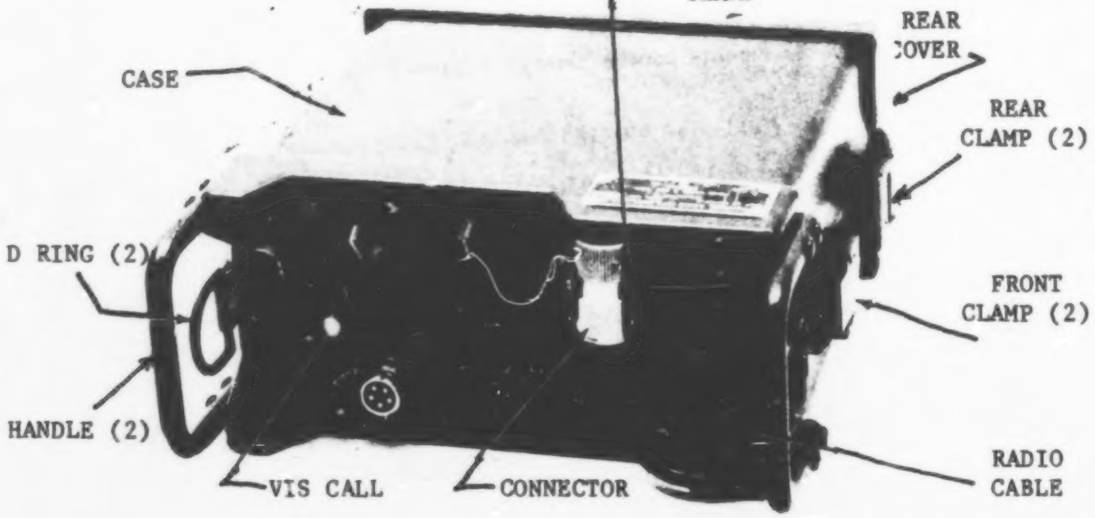


HANDSET H-189/U

Figure 6-9. Radio set control group AN/GRA-39 (B).


REAR
COVER
CASE
REAR
CLAMP (2)
HANDLE (2)
FRONT
CLAMP (2)
D RING (2)
VIS CALL

A. REMOTE CONTROL UNIT


CLAMP
REAR
COVER
CASE
REAR
CLAMP (2)
D RING (2)
FRONT
CLAMP (2)
HANDLE (2)
RADIO
CABLE
VIS CALL
CONNECTOR

B. LOCAL CONTROL UNIT

Figure 6-10. Major components of radio set control group AN/GRA-39 (B).

b. Types of operation.

(1) Telephone communication between remote and local control operators.

(2) Radio transmission and reception from the remote control unit.

(3) Radio transmission and reception from the local control unit.

c. Installation of local control unit.

(1) Unsnap the two rear clamps and remove the rear cover.

(2) Install six BA-30 batteries according to the instructions on the rear of the case.

(3) Replace the rear cover and snap the clamps.

(4) Locate the local control unit near enough to the radio set for the RADIO cable connector to reach the radio set.

(5) Remove the RADIO cable connector from the retaining clip on the front panel.

(6) Aline the keyway on the RADIO cable connector with the keyway slot on the RETRANSMIT R/W receptacle (RT-246/VRC or RT-524/VRC) or the AUDIO connector (RT-841/PRC-77). Press and turn the RADIO cable connector clockwise until it is seated.

(7) Connect the field wire WD-1/TT to the spring-loaded binding posts.

(8) Connect the microphone (M-80) to the AUDIO connector by alining the keyway on the mike with the keyway slot on the AUDIO connector and pressing and turning the connecotr clockwise until seated. Connect the headset (H-140) to the speaker receptacle on the RT-524 or RT-246.

d. Installation of remote control unit.

(1) Perform the procedures described in c(1) through (3) above.

(2) Position the remote control unit as required (up to 3.2 km from the local control unit).

(3) Connect the field wire WD-1/TT to the spring-loaded binding posts.

(4) Connect the handset (H-189 or H-138) to the AUDIO connector by alining the keyway on the handset with the keyway slot on the AUDIO connector and pressing and turning the handset connector clockwise until it is seated.

e. Starting procedure for local control unit.

(1) Turn the POWER switch to ON.

(2) Set the BUZZER VOLUME control to approximately midrange.

f. Operating procedures.

(1) For telephone communication between the remote and local control unit operators, proceed as follows:

(a) Turn on the local and remote control units.

(b) Press the RINGER button on the front panel several times in quick succession to gain the attention of the other operator.

(c) Set the remote control unit TEL-RAD-RAD-SPKR switch to TEL.

(d) Turn and hold the local control unit TEL-REMOTE-RADIO switch to TEL.

(e) Press the handset switch to talk to the other operator; release it to listen.

(2) For radio transmission and reception from the remote control unit, proceed as follows:

(a) Turn on the local and remote control units.

(b) Set the TEL-RAD-RAD/SPKR switch on the remote unit to either RAD or RAD/SPKR.

(c) Set the TEL-REMOTE-RADIO switch on the local control unit to REMOTE.

(d) Adjust the VOLUME control to the desired listening level in the handset or loudspeaker.

(e) Press the handset switch to transmit; release it to receive.

(3) For radio transmission and reception from the local control unit, proceed as follows:

(a) Turn on the local and remote control units.

(b) Set and hold the TEL-REMOTE-RADIO switch to RADIO.

(c) Press the handset switch to transmit; release it to receive.

g. Stopping procedures.

(1) Turn the POWER switch on the local control unit to OFF.

(2) Turn the VOLUME control switch on the remote control unit to OFF.

6-10. RADIO/WIRE INTEGRATION WITH RADIO SET CONTROL GROUP AN/GRA-39 (*). (THIS CONFIGURATION IS A FIELD EXPEDIENT METHOD)

a. Preparation. Prepare a five-pin audio connector (U-182/U or U) by soldering a 5-inch wire to pin A and a 24-inch wire to pin C as shown in figure 6-11.

h. Installation.

(1) Install the AN/GRA-39 (*) components for normal remote operation.

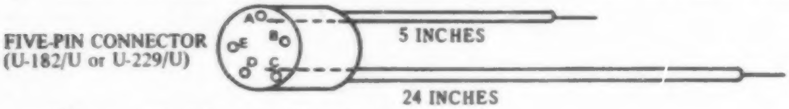


Figure 6-11. Audio connector.

(2) Connect the five-pin audio connector prepared as shown in figure 6-11 to the audio receptacle of the C-2328. Connect the short lead to line binding post L1 of the C-2328 and the long lead to either terminal of an SB-22/PT line pack as shown in figure 6-12.

(3) Connect a short jumper between L2 of C-2328 and the other terminal of the line pack.

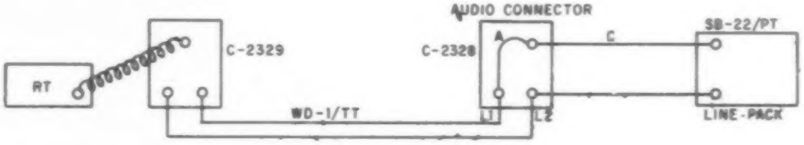


Figure 6-12. Wiring diagram.

6-12. RADIO TEST SET AN/VRM-1

The radio test set AN/VRM-1 is a compact, lightweight, waterproof test set designed specifically for testing the plug-in modules of the R-442/VRC, RT-246/VRC, and RT-524/VRC (AN/VRC-12 equipment). The test set is designed on a simple GO and NO GO principle--a glowing green light indicates a serviceable module; a glowing red light, a defective module.

Section III. INTERCOMMUNICATION SYSTEMS

6-13. AUDIOFREQUENCY AMPLIFIER AM-1780/VRC

a. General. The AM-1780 is a component of installation kits for tracked vehicles. It amplifies the intercom and receiver outputs and is the main junction box for the components of the radio system. All operating controls are external (fig 6-13). Ten connectors located on the unit provide connections for the audio accessories used by crewmembers. One set of field wire binding posts is available to permit the use of a field telephone to contact the crewmembers. Another set provides a meams of connecting any audio input the system.

b. Amplifier, Audio Frequency AM-1780/VRC, Controls, Indicators, and Receptacles (fig 6-13)

INT ACCENT switch-------------------- Controls relative loudness of radio signals.

Position	Function
OFF	Radio and intercom signals have same loudness.
ON	Radio signal level is reduced while intercom signal level is unchanged.

INSTALLATION switch------------------ Set according to the use of the AM-1780/VRC and control boxes.

Position	Function
RETRANS	Disconnects keying circuits between radios and control boxes. For radio retrans. oper.
OTHER	Provides proper termination for radio keying and radio audio output. Used when AM-1780/VRC is connected to radios.
INT ONLY	Provides path for dc power from J508. Used when AM-1780/VRC is not connected to radios.

RAD TRANS switch--------------------- Determines which crewmember control boxes can control keying of receiver-transmitters; radio reception and intercom functions are unaffected.

Position	Function
CDR + CREW	All crewmembers can key receiver-transmitters.
CDR ONLY	Only crew commander can key receiver-transmitters.
LISTENING	Neither crew commander nor crewmembers can key receiver-transmitters.

PWR CKT BKR switch------------------- Controls appliation of dc power Am-1780/VRC circuits and the control boxes; it also provides overload protection.

POWER indicator------------------------ Indicates that power is applied when PWR CKT BKR is set to ON. When lens cap is rotated one-quarter turn counterclockwise, the light does not shine through the lens (for blackout conditions).

AUDIO INPUT binding posts-------------- Connection for 600-ohm audio output from a radio receiver.

LINE binding posts--------------------- Connection for field wire from remotely located telephone or switchboard for communication on intercom circuit.

Receptacle J501------------------------ Connection for cable from receiver-transmitter for passage of main dc power and audio and control circuits between the radio and crewmember control boxes and also receptacle J511.

Receptacle J503------------------------ Connection for cable from a second receiver-transmitter for passage of dc power and audio and control circuits between the radi and crewmember control boxes and also receptacle J509.

Receptacle J508 Connection for cable for a second R-442(*)/VRC for passage of audio output from the receiver to crewmember control boxes. It also provides connection for a cable from a dc power source when the AM-1780/VRC is not connected to radios (INSTALLATION switch must then be set to INT ONLY).

Receptacle J510------------------------ Connection for cable from R-442(*)/VRC for passage of audio output from the receiver to crewmember control boxes.

Receptacle J509------------------------ Connection for cable from receptacle J702 of C-2299/VRC for passage of audio and control circuits between the C-2299/VRC for passage of audio and control circuits between the C-2299/BRC and receiver-transmitter (connected to J503).

Receptacle J511------------------------ Connection for cable from receptacle J701 of C-2299/VRC for passage of audi and control circuits between C-2299/VRC and receiver-transmitter (connected to J501).

Receptacle J504------------------------ Connection for cable from commander's control box for passage of dc power and audio and control circuits between the commander's control box and other crewmember control boxes (connected t J505, J506, and J507).

Receptacle J505, J506, and J507------- Connection for cables from crewmember control boxes for passage of dc power and audio and control circuits between each crewmember control box, the commander's control box, and all radios.

c. Operation.

(1) Turn on the power to the radio set.

(a) Turn the MAIN PWR switch from OFF to NORM or, when the INSTALLATION SWITCH is at INT ONLY, turn the MAIN PWR switch to INT ONLY.

(b) Set the POWER CKT BKR control to ON; observe the POWER indicator light.

(2) Turn the INT ACCENT switch to ON to obtain intercommunication signals stronger than radio signals; turn the switch to OFF to obtain intercommunication signals and radio signals of equal volume.

(3) Set the RADIO TRANS switch as follows:

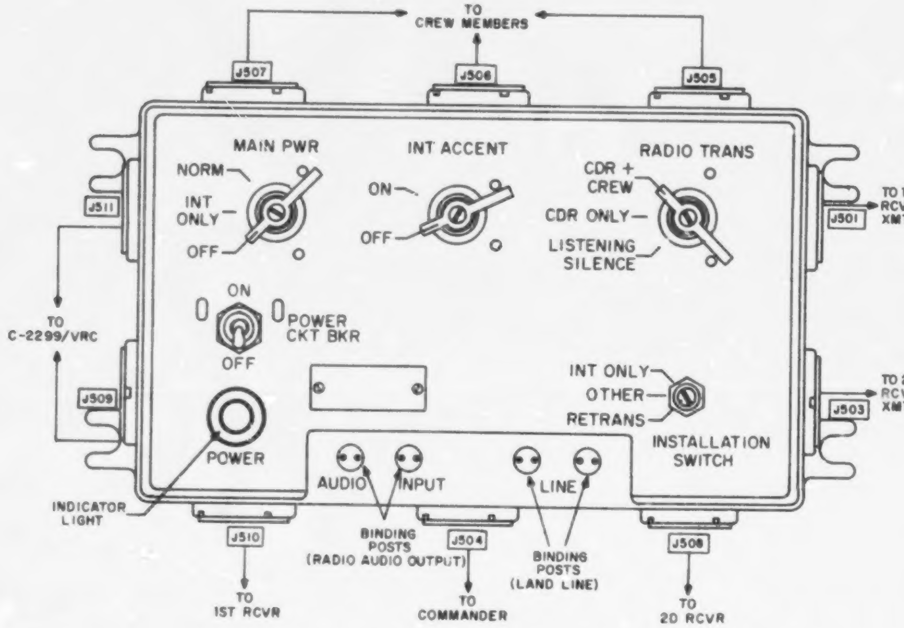

TO CREW MEMBERS
J507
J506
J505
MAIN PWR
NORM
INT ONLY
OFF
INT ACCENT
ON
OFF
RADIO TRANS
CDR + CREW
CDR ONLY
LISTENING SILENCE
J511
TO 1ST RCVR XMTR
J501
TO C-2299/VRC
ON
POWER CKT BKR
OFF
INT ONLY
OTHER
RETRANS
INSTALLATION SWITCH
TO 2D RCVR XMTR
J503
J509
POWER
AUDIO
INPUT
LINE
INDICATOR LIGHT
J510
BINDING POSTS (RADIO AUDIO OUTPUT)
J504
BINDING POSTS (LAND LINE)
J508
TO 1ST RCVR
TO COMMANDER
TO 2D RCVR

Figure 6-13. Audiofrequency amplifier AM-1780/VRC control panel.

(a) If all crewmembers are to operate the receiver-transmitter, turn the RADIO TRANS switch to CDR + CREW.

(b) If only the commander is to operate the receiver-transmitter, turn the RADI TRANS switch to CDR ONLY.

(c) To prevent the commander and crewmembers from operating the receiver-transmitter, turn the RADIO TRANS switch to LISTENING SILENCE.

(4) If the POWER CKT BKR switch moves by itself, an overload is present. To reset the circuit breaker when it trips, set the POWER CKT BKR control to ON.

CAUTION: If the circuit breaker trips again after being reset; do not reset it. Maintenance is required.

(5) Proceed with the appropriate operating procedures for the receivers, receiver-transmitters, and control boxes used in the operation of the radio set.

6-14. INTERCOMMUNICATION CONTROL SET C-2296/VRC

a. General. The C-2296 (fig 6-14) is a component of certain installation kits for armored vehicles. It permits radio communication between personnel inside the vehicle and personnel outside the vehicle. Handset H-207 is attached at the right side of the C-2296, and binding posts on the front of the control set allow field wire and a telephone to be connected to it.

b. Control, Intercommunication Set C-2296/VRC, Controls, Receptacles, and Handset H-207/VRC (fig 3-6)

Control, Intercommunication Set C-2296/VRC, Controls, Receptacles, and Handset H-207/VRC (fig 3-6)

<table>
<tr><th>Control, receptacle, and H-207/VRC</th><th>Function</th></tr>
<tr><td>RAD TRANS-INT switch (SIG-EXT-OFF switch of C-2297/VRC must be set to EXT position before functions of C-2296/VRC can be accomplished.)</td><td>Selects operation that can be performed by H-207/VRC.
<table>
<tr><th>Positon</th><th>Function</th></tr>
<tr><td>RAD TRANS (spring-loaded)</td><td>Provides communication on radio(s) selected by MONITOR switch of C-2297/VRC.</td></tr>
<tr><td>INT</td><td>Provides communication on intercom circuits.</td></tr>
</table></td></tr>
<tr><td>VOLUME control</td><td>Controls level of radio and intercom signals applied to H-207/VRC.</td></tr>
<tr><td>H-207/VRC</td><td>Provides two-way communication on circuit selected by RAD TRANS-INT switch. Push-to-talk switch is depressed to transmit and released to receive. Also, when the switch is depressed and the C-2297/VRC SIG-EXT-OFF switch is in OFF position, it causes the EXT lamp of C-2297/VRC to light attracting the attention of C-2297/VRC user.</td></tr>
<tr><td>LINE binding posts</td><td>Connection for field wire from remotely located telephone or switchboard to provide communication on the intercom circuit.</td></tr>
<tr><td>Receptacle J61</td><td>Connection for circuits through vehicle wiring and cables to C-2297/VRC for passage of dc power and audio and control circuits.</td></tr>
<tr><td>Receptacle J62</td><td>Connection for cable to call indicator which lights when SIG switch of C-2299/VRC is operated to SIG position.</td></tr>
</table>

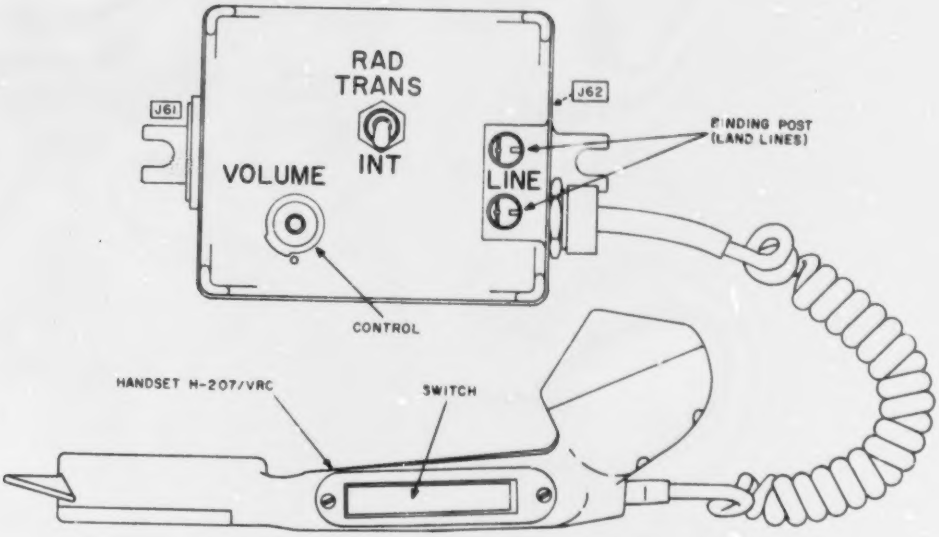


Figure 6-14. Intercommunication control set C-2296.

c. Operation.

(1) To signal personnel inside the vehicle--

(a) Remove the handset H-207 from its stored position.

(b) Press the handset switch. The C-2297/VRC indicator light should light. Also the call indicator will light on the C-2296 and will remain lit until the handset switch is released.

(2) To talk to personnel inside the vehicle after they have answered your signal--

(a) Press the handset switch on the handset H-20.

(b) Speak into the microphone portion of the handset.

(c) Adjust the VOLUME control to the desired volume.

(3) To transmit over the radio set--

(a) Hold the RAD TRANS-INT switch in the RAD TRANS position.

(b) Press the handset switch to transmit. Speak into the transmitter portion of the handset.

(c) Release the handset switch to receive.

(d) At the end of the transmission, release the RAD TRANS-INT switch.

(4) To communicate from a field telephone, after intercommunication has been established--

(a) Connect field wire WD-1/TT between the LINE binding posts of the C-2296 and the field telephone.

(b) Speak into the telephone handset for communications on the intercom circuit.

Note. The indicator lamp lights when personnel inside the vehicle are trying to establish contact with personnel outside the vehicle.

6-15. INTERCOMMUNICATION CONTROL SET C-2297/VRC

a. General. The C-2297/VRC is a component of certain installation kits. It provides connections between the radio set and the audio accessories used by a crewmember of a vehicle or between the radio set and the intercommunication set C-2296 mounted outside the vehicle. The audio connectors and VOLUME control are located on the bottom of the control set. The control panel is shown in figure 6-15.

b. Operation. The C-2279/VRC is normally installed near the driver's position. The controlling functions of the C-2297 are according to instructions in para 6-16c.

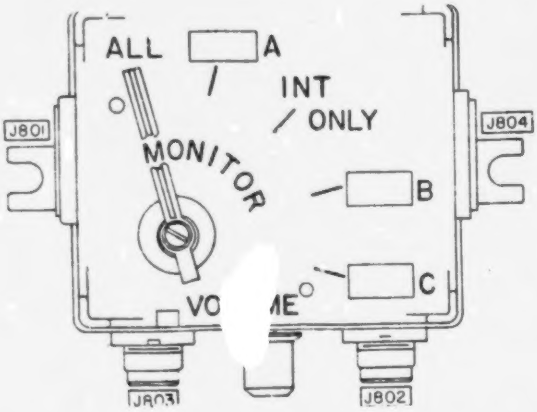
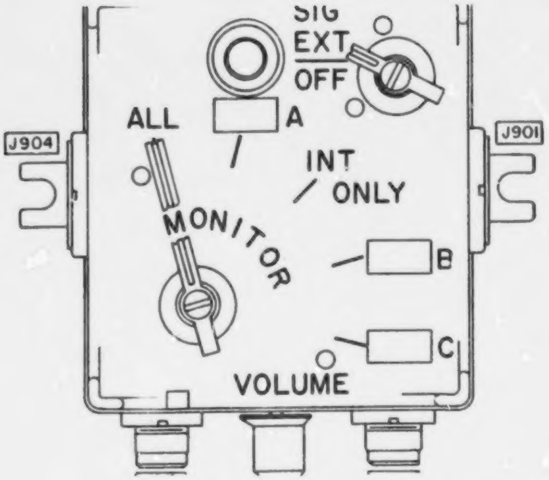


Figure 6-15. Intercommunications control set C-2297/VRC Control Panel.

6-16. INTERCOMMUNICATION CONTROL SET C-2298/VRC

a. General. The C-2298 is a component of certain installation kits. It provides connections between the radio set and the audio accessories used by crewmembers of vehicles. All operating controls and connectors (fig 6-16) are external. The audio connectors and VOLUME control are located on the bottom of the set.



SupR
80170

Figure 6-16. Intercommunications control set C-2298/VRC control panel.

b. Operation.

(1) To monitor incoming signals of different components, operate the MONITOR switch for the C-2298/VRC according to instructions in para 6-16c.

(2) Adjust the VOLUME control for the desired volume in the audio accessory.

Note. The adjustment of the VOLUME controls on the receiver and receiver-transmitters will affect the volume at the audio accessory when the MONITOR switch is in any position except ALL. Adjust the VOLUME controls on the receiver and receiver-transmitters for equal volume levels when the MONITOR switch is in a position other than ALL.

(3) To transmit on the first receiver-transmitter--

(a) Turn the MONITOR switch to ALL, A, or B.

(b) Press the PUSH-TO-TALK switch of the microphone connected to J802 of the control box and speak into the microphone.

(4) To transmit on the second receiver-transmitter--

(a) Turn the MONITOR switch to C.

(b) Press the PUSH-TO-TALK switch of the microphone connected to J802 of the control box and speak into the microphone.

(5) To use the intercom--

(a) If using a microphone connected to J803 (marked yellow), press the PUSH-TO-TALK switch and speak into the microphone.

(b) If using a microphone connected to J802,

1. Turn the MONITOR switch to INT ONLY.

2. Press the PUSH-TO-TALK switch and speak into the microphone.

c. Controls, Intercommunication Set C-2297/VRC and C-2298/VRC, Controls, Indicator, and Receptacles.
(fig 6-15 and 6-16)

MONITOR switch------------------------		a. In C-2297/VRC and C-2298/VRC, it selects the radios and intercom intercom operation to be controlled by audio accessories connected to audio accessory receptacles. b. In C-2296/VRC, the switch functions are also available to the C-2296/VRC when the SIG-EXT-OFF switch is set to EXT position.
	Position	Function
	ALL	a. Received audio signals of "A" radio and receivers "B" and "C" can be heard. b. "A" radio can be used for transmission, provided no other crewmember keys his audi accessory on intercom. c. Talking and Listening can be accomplished on intercom.
	A	a. Received audio signals of "A" radio can be heard. b. "A" radio can be used for transmission, provided no other crewmember keys his audio accessory on intercom. c. Talking and listening on intercom can be accomplished.
	INT ONLY	Only talking and listening on intercom can be accomplished.
	B	a. Received audio signals of receiver "B" can be heard. b. "A" radio can be used for transmission, provided no other crewmember keys his audio accessory on intercom. (Usually "A" radio is tuned to receiver "B" for the transmission.) c. Talking and listening on itercom can be accomplished.
	C	a. Received audio signals of receiver "C" or "B" radio can be heard. b. "B" radio can be used for transmission, provided no other crewmember keys his audio accessory on intercom. c. C-2298/VRC: intercom can only be accomplished by crew commander (connected to J504 of AM-1780/VRC).

6-17. FREQUENCY SELECTOR CONTROL C-2742/VRC

a. General. The C-2742/VRC is a component of certain installation kits used with the automatic receiver-transmitter RT-246. It extends the control of power and the selection of preset channels to a remote location within the vehicle. A selector switch is located on the face of the control (fig 6-17). The PWR switch on the right allows control of power to the complete radio and selection of higher or lower transmitter output. The SW switch permits control of the receiver-transmitter at the C-2742.

b. Control, Frequency Selector C-2742/VRC, Contorls, Indicator, and Receptacles (fig 6-17).

Control, indicator, and receptacles	Function	
CHAN SEL switch	Ten position switch that automatically selects any one of ten frequencies that have been preset on the 10 channel pushbuttons of the RT-246(*)/VRC (fig 3-2).	
PWR SW	Controls dc power and rf transmitting power of RT-246(*)/VRC.	
	Position	Function
	OFF	Turns off dc power to RT-246/(*)/VRC.
	LO	Turns on dc power to RT-246(*)/VRC which arranges to transmit on low rf power.
	HI	Turns on dc power to RT-246(*)/VRC which arranges to transmit on high rf power.
SW switch and CONTROL indicator	(Two C-2742/VRC's can be connected in tanden with each other and, in turn, connected to the RT-246-(*)/VRC). SW switch is a spring-loaded switch, when activated, transfers the functions of the CHAN SEL and PWR switch of the other C-2742/VRC to this C-2742/VRC. When the switch is operated, the CONTROL indicator lights and the CONTROL indicator of the other C-2742/VRC goes out.	
Receptacles J70 and J72	Connection for cables to RT-246(*)/VRC or another C-2742/VRC for passage of dc power and control circuits.	

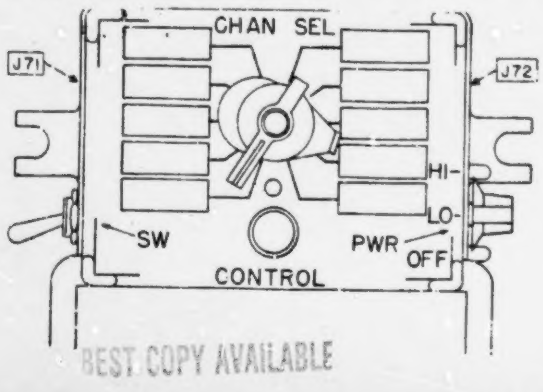


Figure 6-17. Frequency selector control C-2742 control panel.

c. Operation.

(1) Turn the POWER switch on the receiver-transmitter to the REMOTE position.

(2) Lift the SW switch to obtain control of the reciver-transmitter, check to see that the CONTROL indicator light comes on.

(3) Select any one of the 10 preset channels by turning the CHAN SEL switch to the appropriate position as marked on ther write-in surfaces of the control panel.

Note. The travel of the CHAN SEL switch may be limited by the catch lock provided. To set the catch, pull the selector switch away from the shaft, turn it to the desired position, and place it back against the switch shaft.

(4) Select low or high transmitter power output by turning the PWR switch to LO or HI.

(5) If the CONTROL indicator light goes out, another frequency selector control in the radio system has obtained control of the receiver-transmitter. To regain control, lift the SW switch.

(6) To turn off the power in the receiver-transmitter from the C-2742, turn the PWR switch to OFF.

Section IV. ANTENNA EQUIPMENT FOR FM RADIOS

6-18. ANTENNA EQUIPMENT RC-292

a. General. Antenna equipment RC-292 (fig 6-18) is an elevated, wide-band modified, ground plane antenna designed to operate with, and increase the distance range of, FM radio sets. The length of the antenna elements which must be preadjusted, is accomplished by changing the number of antenna mast sections that make up the antenna elements.

b. Characteristics. Technical characteristics of the equipment are as follows:

(1) Use: Used with all FM radios (20.0 to 76.0 MHz).

(2) Frequency range: Varies with the number of antenna sections used, as shown in table 6-2.

(3) Planning ranges:

(a) Between two radio sets RT-246/VRC or RT-524/VRC, each equipped with antenna equipment RC-292--up to 58 km; between two radio sets RT-246/VRC or RT-524/VRC, one equipped with a regular whip antenna and the other with antenna equipment RC-292--up to 40 km.

(b) Between two radio sets AN/PRC, each equipped with antenna equipment RC-292--up to 19 km; between two radio set AN/PRC, one equipped with the long whip antenna and the other with antenna equipment RC-292--up to 13 km.

(4) Erection time: 15 minutes.

(5) Erected height: 41 1/2 feet.

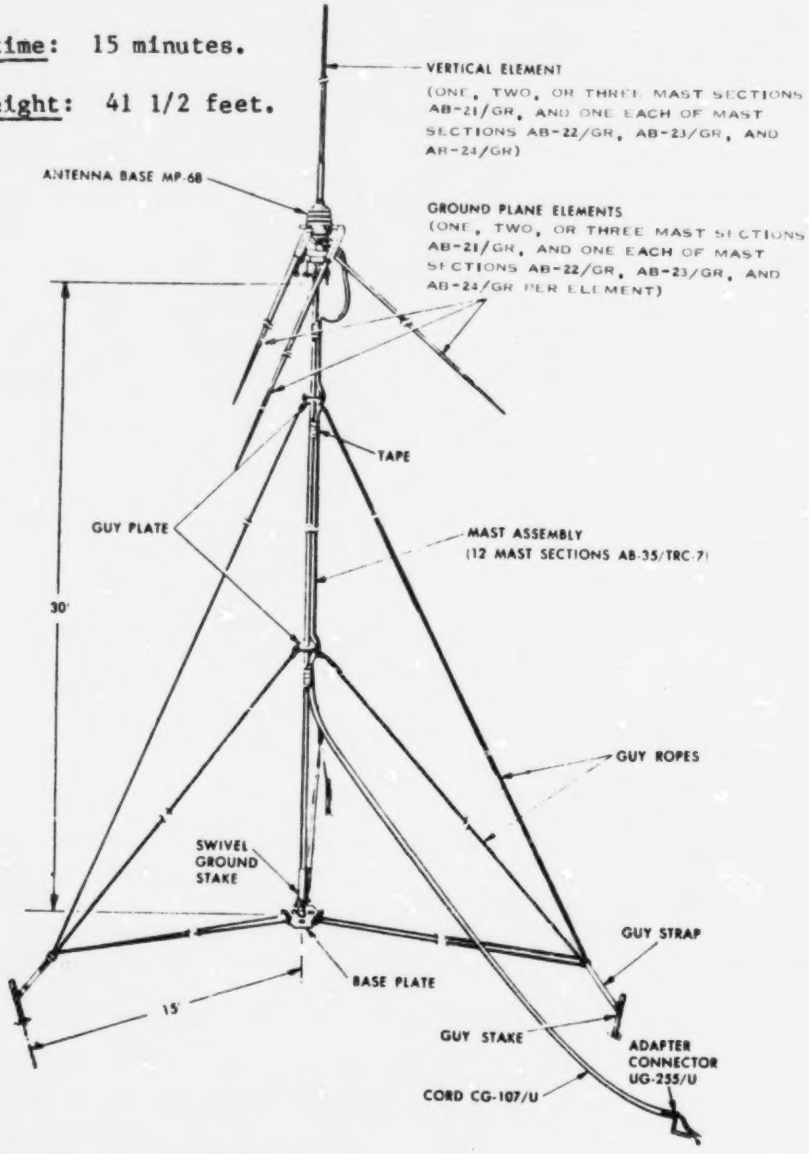

VERTICAL ELEMENT
(ONE, TWO, OR THREE MAST SECTIONS AB-21/GR, AND ONE EACH OF MAST SECTIONS AB-22/GR, AB-23/GR, AND AB-24/GR)
ANTENNA BASE MP-68
GROUND PLANE ELEMENTS
(ONE, TWO, OR THREE MAST SECTIONS AB-21/GR, AND ONE EACH OF MAST SECTIONS AB-22/GR, AB-23/GR, AND AB-24/GR PER ELEMENT)
TAPE
GUY PLATE
MAST ASSEMBLY
(12 MAST SECTIONS AB-35/TRC-7)
30'
GUY ROPES
SWIVEL GROUND STAKE
GUY STRAP
BASE PLATE
15'
GUY STAKE
ADAPTER CONNECTOR UG-255/U
CORD CG-107/U

Figure 6-18. Antenna equipment RC-292.

(6) Weight (complete): 48 pounds.

WARNING: When erecting a RC-292 antenna, locate the antenna a distance at least twice the height of the antenna away from power lines to avoid shock hazards.

Table 6-2. Antenna and Ground Plane Elements.

Operating frequency (MHz)	Number of antenna sections required	Sections used				Number of ground plane sections required	Ground plane sections used			
		AB-21/GR	AB-22/GR	AB-23/GR	AB-24/GR		AB-21/GR	AB-22/GR	AB-23/GR	AB-24/GR
30 to 36.5	4	1	1	1	1	15	2	1	1	1
36.5 to 50.5	3	0	1	1	1	12	1	1	1	1
50.5 to 75.95	2	0	1	0	1	9	0	1	1	1

6-19. ANTENNA, LOOP AT-784/PRC

a. Description. Antenna, Loop AT-784/PRC when used in conjunction with Radio Set AN/PRC-77, AN/VRC-12 or their equivalents, comprises a homing device that enables the operator to find the direction of a transmitted signal within the frequency range of 30 to 76 MHz. Use the AT-784/PRC for reception only. Do not transmit when the AT-784/PRC is connected to the radio set; remove all other antennas from the radio set. Keep the ATTENUATOR switch to 0 whenever the AT-784/PRC is not in use. The unshielded loop antenna of Antenna AT-1082/PRC is used to pick up a homing signal and its extendable sense whip antenna is used to determine the direction of the transmitted signal. The AT-1082/PRC is not provided wit an azimuth indicator, since highly accurate bearings are not generally required of homing purposes.

b. Operation. The operating procedure of Antenna Loop AT-784/PRC for homing-in on a modulated or unmodulated carrier is described below.

(1) Check to see that the AT-1082 is connected to the receiver. Remove all other antennas from the receiver. Set the ATTENUATOR control to 0.

(2) On the receiver, tune to the operating frequency, set the volume control for maximum loudness and set the squelch control to OFF when there is such a provision.

(3) Unfold the loop antenna and set the BANDSWITCH and FINE TUNE controls to the positions that are closest to the frequency setting on the receiver. For example, to tune to 45.80 MHz, set the BANDSWITCH control to 40 and the FINE TUNE to 5.

(4) Hold the AT-1082 vertically and rotate it clockwise and counterclockwise for maximum signal indication on the receiver. Readjust the FINE TUNE control for a greater output signal on the receiver. A maximum signal indication wil be indicated by a loud audio output on the receiver because of a modulated carrier or by maximum receiver quieting because of an unmodulated carrier. Do not use the FINE TUNE control setting as a standard in determining the transmitter frequency.

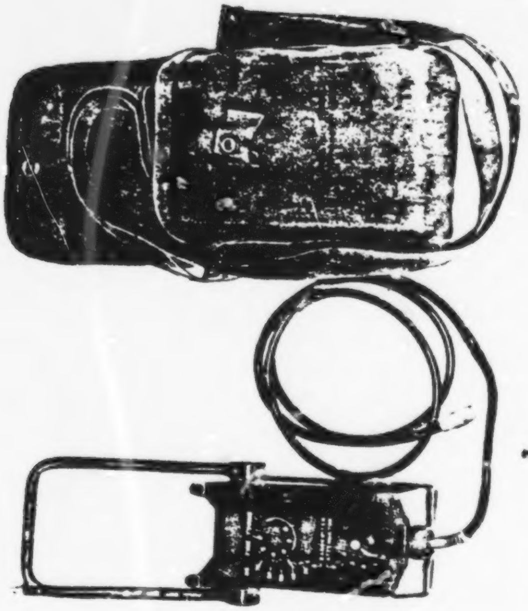


Figure 6-19. Antenna, Loop AT-784/PRC.

(6) To determine the direction of the signal, rotate the AT-1082 90° to obtain a null indication on the receiver. The loop antenna is now broadside to the signal source and is indicated by the SIGNAL NULL arrows on the signal direction label on top of AT-1082. Extend the sense ship antenna. This action will cause a signal output from the receiver. Starting with the broadside position listen for the maximum output signal while rotating the AT-1082 clockwise and then counterclockwise from the broadside position. Set the AT-1082 to the position that provides the strongest signal indication in the receiver. The AT-1082 is again in line with the transmitting signal source and the signal source is in the direction away from the sense whip antenna as indicated by the SIGNAL MAX arrow on the signal direction label. For better orientaion, the operator holds the AT-1082 at eye level and with SIGNAL MAX arrow on the signal direction label. For better orientation, the operator holds the AT-1082 at eye level and with SIGNAL MAX arrow pointing away from himself move his body clockwise and counterclockwise to rotate the AT-1082.

(7) Retract the sense whip antenna and using the loop antenna of the AT-1082, home-in on the signal source with the null indication.

(8) Adjust the ATTEINUATOR control for a comfortable listening level of the received signal.

Notes.

6-20. ANTENNA AT-984A/G

a. Description. Antenna AT-984A/G (fig 6-20) is a long-wire, end-fed, directional antenna that is used to extend communication distance of FM tactical radio sets in the 30.00-MHz to 76.00-MHz range. It is used with radio set AN/PRC-77.

b. Components. Components of the AT-984A/G include a carrying bag, reel, 150-foot antenna wire, and terminal lug.

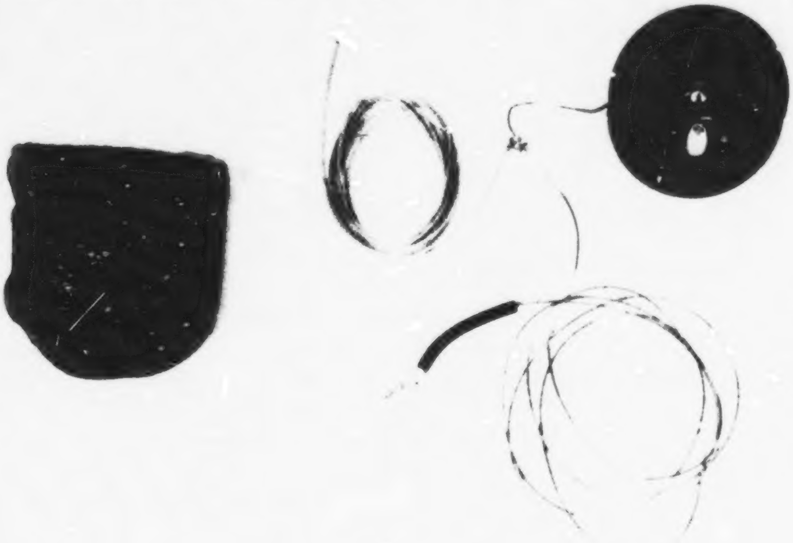


Figure 6-20. Antenna AT-984A/G.

6-21. WHIP ANTENNAS

The whip antenna is the most commonly used antenna for tactical radio communication. The whip antenna is especially useful with portable or mobile radio equipment. Whip antennas up to 15 feet in length are useful for mobile vehicular operation. Longer whip antennas must be guyed. Whip antennas normally are constructed of sections of metal tubing or strips of laminated metal that can be taken apart or folded when not in use. These features increase the portability of field radio sets. Sometimes a whip antenna mounted on a vehicle must be left fully extended so that it can be used while the vehicle is in motion. The base mounting insulator of such an antenna is fitted with a coil spring attached to a mounting bracket on the vehicle. The spring base holds the whip antenna nearly vertical and protects the antenna while the vehicle is moving. If the antenna is vertical and hits an obstruction, the whip usually will not break because most of the shock will be absorbed by the spring base.

CAUTION. If an antenna must be left fully extended while the vehicle is in motion, powerlines should be avoided.

6-22. ANTENNA SITING.

a. The siting of a tactical radio set and its associated antennas usually is a compromise between technical requirements and tactical condideration of cover and concealment. A radio station should be placed in a position that will insure communication with all stations with which it must operate.

b. The transmitter and receiver will have greater range if the antenna is located in a position that is high and clear of hills, buildings, cliffs, densely wooded areas, and other obstructions. Dips, depressions, valleys, and low places are poor for radio transmission and reception because the surrounding high terrain tends to impede the RF energy. Weak signals may be expected if the radio set is operated near steel bridges, underpasses, powerlines, or electrical circuits.

c. All permanent and semipermanent radio sites should be camouflaged for protection against both air and ground observation. However, the antenna should not be allowed to touch trees, brush, or comoulflage material.

d. The following rules are useful guides for siting radio antennas and for improving radio communication in wooded areas:

(1) Antennas should be located on hills overlooking the surrounding terrain and wooded areas.

(2) Antennas should be located in clearings on the edge farthest from the distant station. The clearing should extend at least 100 yards from the antenna in the direction of the distant station.

(3) Directional antennas should be oriented in straight paths. When an intervening wooded area or the terrain masks the transmission path, the antenna can be oriented slightly off course, particularly when the off-course path is unobstructed.

(4) Antennas should be located as high as possible when the radio site is located directly behind an intervening mask.

(5) Antennas should not be locted in narrow valleys or between ridges.

(6) Complete antenna systems, such as ground planes and dipoles, should be used when possible, as they are more effective than fractional wavelength whip antennas.

(7) Tree branches must be cleared from antenna sites. If an antenna touches foliage, the signal will be grounded, especially during rainy weather.

e. For the best results in desert areas, radio antennas should be located on high ground immediately overlooking the surrounding terrain. Whip antennas used in desert terrain will lose one-third of their normal range. This loss is due to the dryness of the ground that causes poor conductivity. For this reason, it is important to use complete systems, such as antenna horizontal dipoles and vertical antennas with adequate counterpoises.

f. Antennas should be sited in mountainous areas as follows:

(1) Directional antennas should be oriented at small angles off the straight course when high mountains lie in the transmission path.

(2) Valleys and gaps should be used for transmission paths between mountains.

(3) When a radio station is sited directly behind a high intervening mountain mask, the antennas should be located on the highest ground possible.

(4) The antenna cables should be elevated above the ground to insure that they will not be buried in the snow or frozen to the ground.

(5) The antenna joints and cable connectors should be kept out of snow and water.

(6) During the winter, the metal mast sections and antenna cables should be handled carefully, since they become brittle at low temperatures.

(7) When the ground is frozen, counterpoises should be installed for antennas.

(8) Antennas should be located on the top or on the forward slope of a mountain. If possible, they should be high enough to provide line-of-sight paths.

(9) Complete antenna systems, such as ground planes and dipoles, should be used when possible, as they are more effective than functional wavelength whip antennas, especially for operating over snow or frozen ground.

Notes.

Notes.

CHAPTER 7

FIELD EXPEDIENT ANTENNAS

7-1. GENERAL

Poor radio communication or a lack of radio communication can be caused by the excessive separation of transmitter and receiver, unfavorable terrain, or a variety of conditions. It is imperative that communication personnel understand the application of field expedients for maintaining radio communication. When available, antenna equipment RC-292 should be used to increase range or to obtain better communication with FM radios.

7-2. VERTICAL ANTENNAS

Practically all radio sets in a combat area use whip antennas. Whip antennas are commonly used with sets should mounted in vehicles and with manpack sets that operate in motion. More detailed information on antennas can be found in the manual pertinent to the set being used and in FM 24-18. Whip antennas may be broken in use. When replacement are not immidiately available, personnel can improvise a satisfactory antenna by using field wire WD-1/TT (fig 7-1) or by lashing together the broken antenna pieces (fig 7-2).

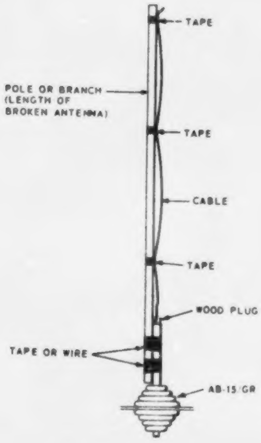

TAPE
POLE OR BRANCH (LENGTH OF BROKEN ANTENNA)
TAPE
CABLE
TAPE
WOOD PLUG
TAPE OR WIRE
AB-15/GR

Figure 7-1. Using field wire WD-1/TT for emergency repair of whip antennas.

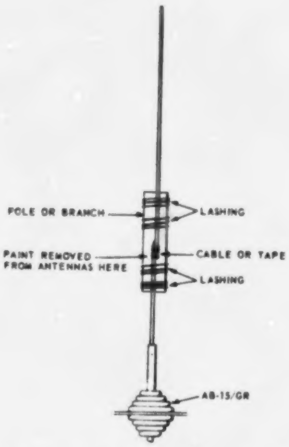

POLE OR BRANCH
LASHING
PAINT REMOVED FROM ANTENNAS HERE
CABLE OR TAPE
LASHING
AB-15/GR

Figure 7-2. Using broken antenna sections for emergency repair of whip antennas.

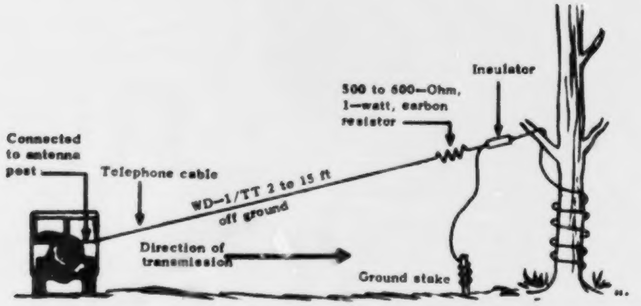
7-3. HORIZONTAL ANTENNAS

When the situation does not require mobility or when antenna group RC-292 is not available, greater range can be achieved through the use of horizontal antennas. Figures 7-3, 7-6, and 7-7 show the construction of three types of horizontal antennas that will greatly extend the transmission range of a radio set.

to reject or reduce signals recived from other directions. The long-wire antenna must be a minimum of 3 wavelengths (100 to 150 feet) long and should be made of field wire WD-1/TT. One end of the directional long-wire antenna is connected directly to the antenna receptacle on the receiver-transmitter, and the other end is pointed toward the station with which communication is desired.

b. Wave antenna with resistor and ground. The wave antenna (fig 7-3) is a long-wire antenna that is highly directional. The physical length of this or any antenna is computed by using the formula $L = \frac{468}{F\ (\text{MHz})}$ in which L represents the antenna length in feet, 468 (142 for meters) is the constant, and F represents the operating frquency in megahertz. For example, if you were operating on 24 megahertz and you desired to construct a wave antenna of 2 1/2 wavelengths, you would compute the half-wavelength as follows:

$L = \frac{142}{F\ (\text{MHz})} = \frac{142}{} = 5.9$ m $\quad L = \frac{468}{F\ (\text{MHz})}$, or $L = \frac{468}{24}$, or L = 19.5 feet


Connected to antenna post
Telephone cable
WD-1/TT 2 to 15 ft off ground
Direction of transmission
500 to 600—Ohm, 1—watt, carbon resistor
Insulator
Ground stake

Formula for length of Half Wave Length (in feet) $= \frac{468}{\text{Frequency (in MHz)}}$

Note: This antenna is preferably two or more wave lengths long.

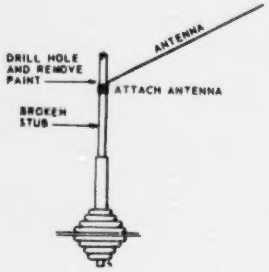


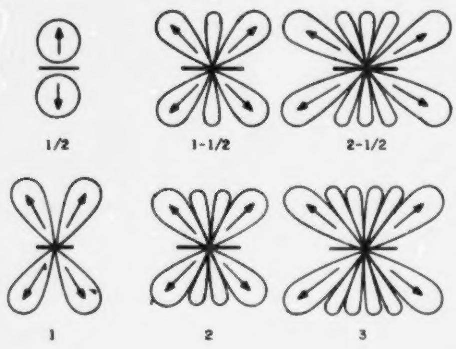
Figure 7-3. Wave antenna for use with AM and FM radios.

Figure 7-4. Expedient method a wave antenna.

(1) If 19.5 feet represents a half-wave, then one full wave is equal to 39 feet (twice the length of the half-wave). Multiply 39 feet by 2 1/2 for the actual length of the 2 1/2-wave antenna. The actual length is 97.5 feet. As the antenna length is increased from the half-wavelength, the antenna becomes more unidirectional. This is illustrated in figure 7-5. The lobes represent the direction of transmission.

(2) A suspended antenna causes considerable pull on the radio set at the connection. Difficulty may be experienced in keeping the antenna connected to the binding post. One method of overcoming the difficulty is as follows: Remove the regular whip antenna from the mounting base. Place in the base a broken stub that most surely will be available. Drill a hole through the broken stub, push the end of the antenna through the hole, and tie the antenna to the stub. The connection to the radio set is already on the stub. This expedient will keep the weight of the wire from pulling the wire away from the binding post. Be sure to remove the paint from the area on the stub where the antenna is connected (fig 7-4).

c. Half-rhombic antenna. The half-rhombic antenna (fig 7-7) is used primarily with FM radios. A relatively large antenna site is required for its erection. To insure satisfactory performance, each leg of a half-rhombic antenna should be a minumum of 1 wavelength at the lowest frequency used. A typical military half-rhombic antenna consists of 100 feet of field wire WD-1/TT, erected over a single 30 foot support pole, with an 80-foot counterpoise laid below the antenna. The 100 feet of wire should be erected on the supporting pole so that each leg is 50 feet long. One leg of the antenna terminates at a 500- or 600-ohm resistor. One end of the counterpoise also terminates at the resistor. A lead-in wire is attached between the other leg of the antenna and the radio set. The remaining end of the counterpoise is then grounded to the vehicle. The supporting pole should be wooden and should be guyed with rope. In operation, current can flow only from the transmitter toward the resistor. This resistor absorbs energy that is not radiated and in so doing prevents any reflection back along the antenna. The direction of transmission is from the radio set end of the antenna toward the resistor end.



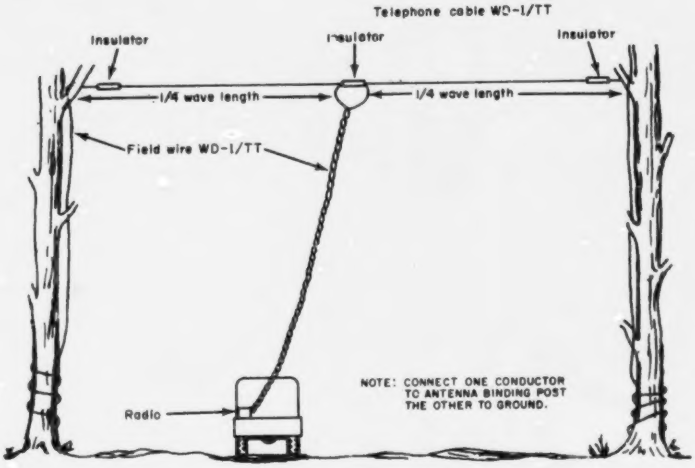


Figure 7-5. Radiation patterns from one-half wavelength to 3 wavelengths.

Figure 7-6. Center-fed hertz (doublet) antenna for use with AM and FM radios.

d. Center-fed hertz (doublet) antenna. The center-fed hertz (doublet) antenna (fig 7-6) is a half-wave antenna consisting of two quarter-waves on each side of the center insulator. The antenna is suspended in the air at a height of 10 to 50 feet. For ideal use, the antenna should be suspended as close to one-half wavelength above ground as possible. The formula for computing the physical length of this antenna is the same as that for the wave antenna. Bring the twisted pair of lead-in wires to the front panel of the radio set. Strip approximately one-half inch of insulation from each end of the wire. Bring one lead to the 50-ohm terminal and insert it into the small center connection of the connector (fig 7-8). The lead must make contact with teh "hot" or center, connection and must not touch the outside shell. Take the other lead and ground it by loosening any screw on the front panel, inserting the wire behind the screw, and tightening the screw. The antenna radiates on both sides, broadsied to its length (fig 7-5), and will greatly increase the transmission planning range of the radio set.

7-4. ELEVATED ANTENNAS

a. An elevated antenna (fig 7-9) can be constructed from materials readily available in any combat unit. The standard vehicular antenna complete with bracket and mast base can be raised on poles to a desired height. The antenna can be connected to the radio, set with standard field wire WD-1/TT. The guy wires, with insulators properly installed, can be used as the ground plane or counterpoise. The guy wires, with insulators properly installed, can be used as the ground plane or conterpoise. The antenna, properly constructed, will provide a radiation pattern that is omnidirectional in the horizontal plane.

b. A ground plane omnidirectional jungle antenna (fig 7-10) can be used with FM radios instead of the antenna equipment RC-292 when the RC-292 is not available. The jungle antenna has a radiation pattern of 360°; thus, it is omnidirectional. Its length depends on the operating frequency. Its height is variable, but the lead-in wire should not exceed 13 meters. The three bamboo spacers must be equal in length. To erect the antenna, toss the rock over a tree limb that is at least 8 feet above the ground.

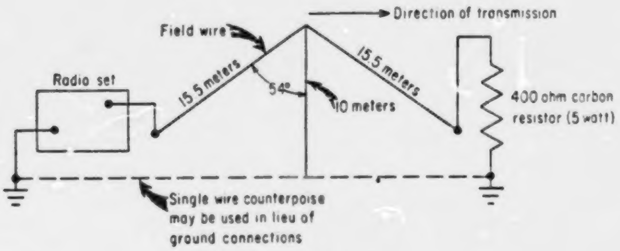
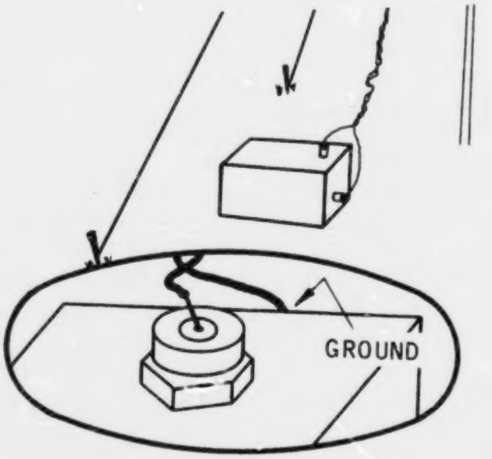

Direction of transmission
Field wire
Radio set
15.5 meters
54°
10 meters
15.5 meters
400 ohm carbon resistor (5 watt)
Single wire counterpoise may be used in lieu of ground connections

Figure 7-7. Half-rhombic antenna.

Figure 7-8. Lead-in connection to radio set.



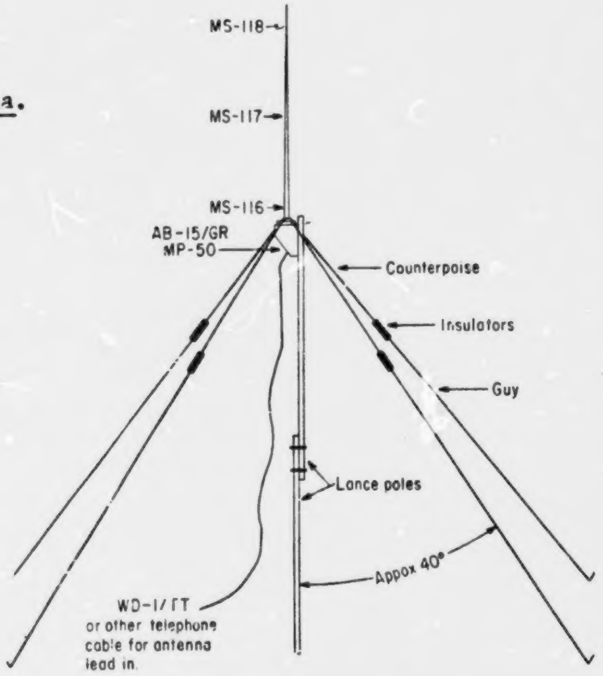

MS-118
MS-117
MS-116
AB-15/GR
MP-50
Counterpoise
Insulators
Guy
Lance poles
Approx 40°
WD-1/TT or other telephone cable for antenna lead in.

Figure 7-9. Improvised elevated antenna.

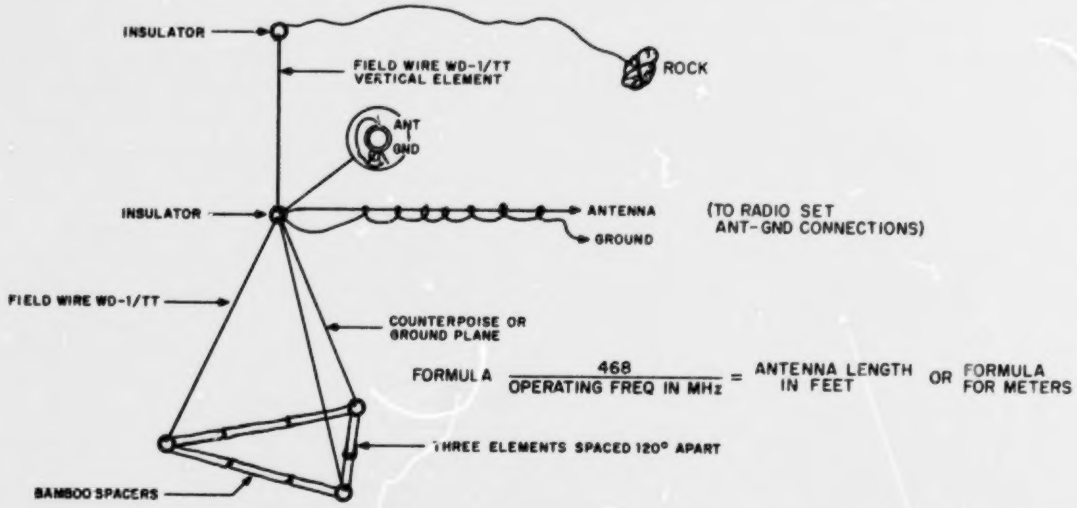

INSULATOR
FIELD WIRE WD-1/TT VERTICAL ELEMENT
ROCK
ANT
GND
INSULATOR
ANTENNA
GROUND
(TO RADIO SET ANT-GND CONNECTIONS)
FIELD WIRE WD-1/TT
COUNTERPOISE OR GROUND PLANE
FORMULA $\frac{468}{\text{OPERATING FREQ IN MHz}}$ = ANTENNA LENGTH IN FEET OR FORMULA FOR METERS
THREE ELEMENTS SPACED 120° APART
BAMBOO SPACERS

Figure 7-10. Ground plane omnidirectional jungle antenna (field expedient).

c. A balloon-type antenna (fig 7-11) is erected by inflating a ballon with helium and raising it to a height of 150 to 240 feet (height varies with frequency). The antenna is omnidirectional and vertically polarized. It can be used both for AM and FM radio sets. Field wire WD-1/TT is utilized as the antenna element.

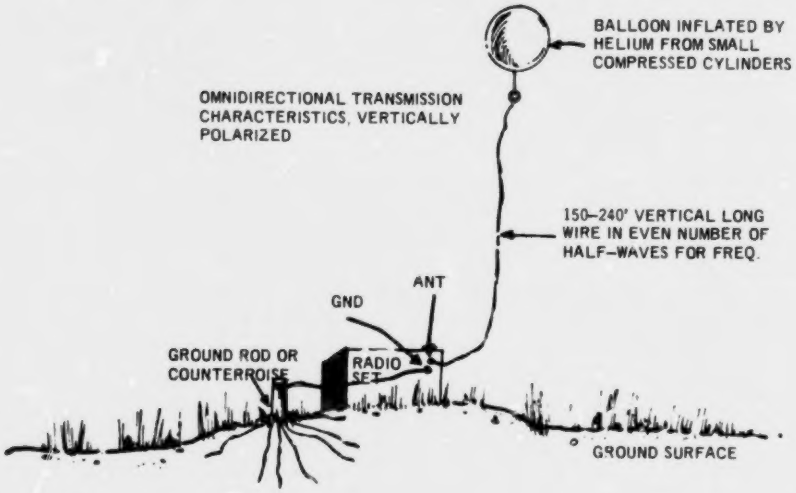

BALLOON INFLATED BY HELIUM FROM SMALL COMPRESSED CYLINDERS
OMNIDIRECTIONAL TRANSMISSION CHARACTERISTICS, VERTICALLY POLARIZED
150–240' VERTICAL LONG WIRE IN EVEN NUMBER OF HALF-WAVES FOR FREQ.
ANT
GND
GROUND ROD OR COUNTERPOISE
RADIO SET
GROUND SURFACE

Figure 7-11. Balloon-type support for omnidirectional vertical antenna for AM or FM radio sets.

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Notes.

CHAPTER 8

AMPLITUDE MODUALTED RADIO EQUIPMENT

Section I. RADIO SETS AN/GRC-19 AND AN/VRC-24

8-1. GENERAL

a. In some organizations, AM radios are authorized down to unit (battery, company, troop) level. AM radios have greater distance ranges than FM radios and also have greater traffic-handling capacity.

b. AM radios operate in the high-frequency band and are employed commonly throughout the Army. AM radios are installed in wheeled and tracked vehicles and can be operated while the vehicles are stationary or in motion. Doublet or long-wire antennas can be used while the vehicle is stationary to obtain greater distance ranges. Trained communication specialists are required for operation of AM radios.

8-2. RADIO SET AN/GRC-19

a. General. Radio set AN/GRC-19 (fig 8-1) consists of transmitter T-195/GRC and receiver R-392/URR on mount MT-851/GRC-19, a 15 foot whip antenna, necessary audio accessories, and interconnecting power and control cables. The set is designed to provide voice or continuous-wave communication between moving or stationary vehicles.

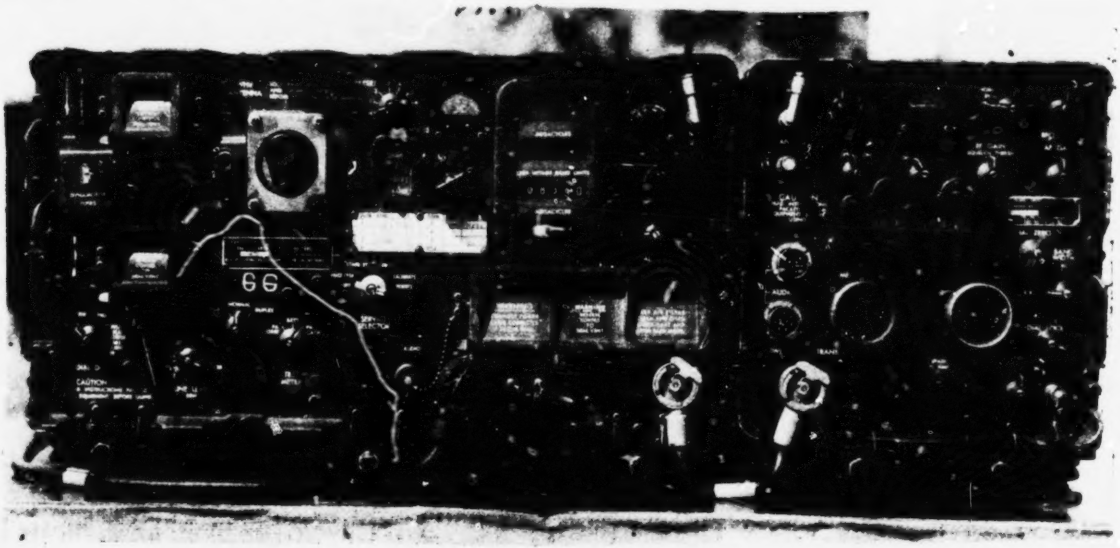

Figure 8-1. Radio set AN/GRC-19.

b. Operational capabilities. The AN/GRC-19 is capable of--

(1) Transmission or reception on one frequency.

(2) Duplex operation.

(3) Relay (automatic retransmission) operation.

(4) Remote control operation.

c. Characteristics.

(1) Type of installation: Vehicular.

(2) Type of modulation: Amplitude modulation.

(3) Power output (nominal): 100 watts.

(4) Power requirements: 28 volts direct current.

Note. This power requirement necessitates that a special electrical system, commonly known as a 100-ampere kit, be installed in the vehicle. For best results, 28 volts are required.

(5) Antenna:

(a) Whip: 15 feet long (three MS-116's one MS-117, one MS-118).

(b) Doublet.

(6) Additional characteristics: See table 8-1.

8-3. RADIO SET AN/VRC-24

a. General. Radio set AN/VRC-24 (fig 8-2) is the VHF-UHF radio that links ground, units with tactical air support elements. It includes a receiver-transmitter group, a mounting, an antenna, a loudspeaker, a microphone, interconnecting cables, and a radio set control.

b. Components.

(1) Receiver-transmitter group OA-2648/VRC-24. The receiver-transmitter group consists of a receiver-transmitter, a dynamotor (mounted on the chassis of the receiver-transmitter), and a case. All operating controls are located on the front panel. A blower is fastened to the case to provide forced air circulation for heat dissipation. The dynamotor is connected to the vehicle storage battery and generates the operating voltages for the receiver-transmitter.

(2) Mounting MT-1436/U. The mounting consists of two platforms separated by four shock mounts. The lower platform is drilled for bolting the mounting to a vehicle. The clamps and thumbscrews secure the receiver-transmitter to the upper platform.

(3) Antenna AT-803/VR. The antenna (not shown) is approximately 10 inches long and is designed for mobile operation.

(4) Audio-accessories. Audio accessories include a microphone M-29/U and a loudspeaker LS-166/U.

(5) Cables. The cable assemblies interconnect components of the radio set and connect the radio set to vehicle storage battery.

(6) Radio set control C-1439/U. The radio set control permits operation of the radio set form a positon a short distance (maximum of 10 feet) away from the receiver-transmitter. The control may be used for radio, interphone, or simultaneous radio and interphone operation.

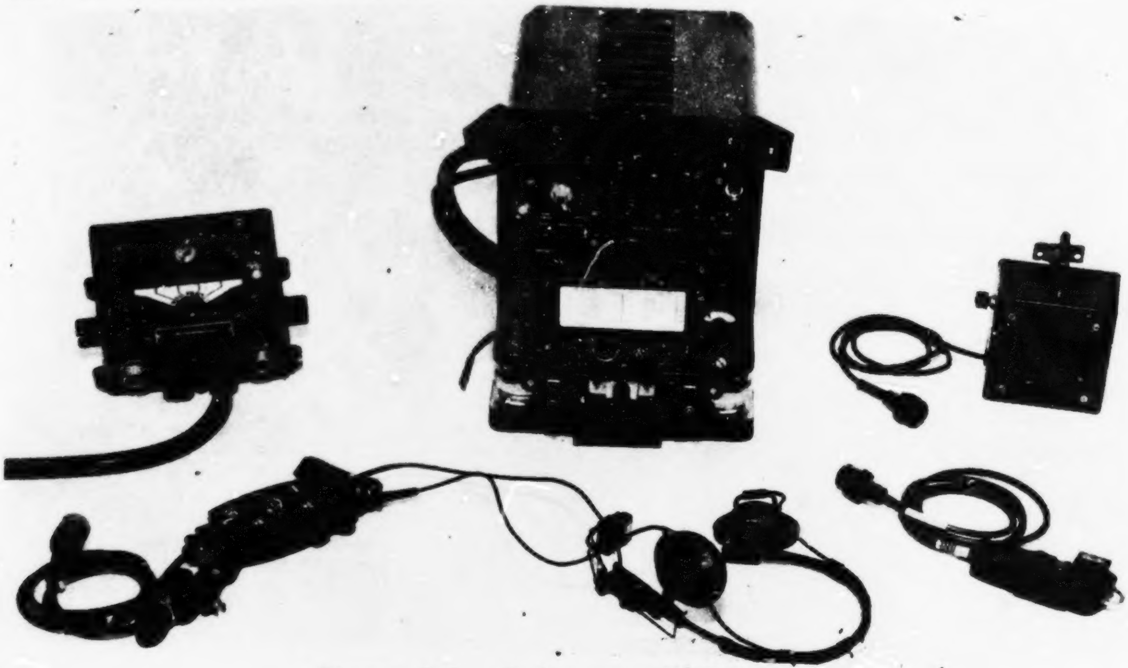

Figure 8-2. Radio set AN/VRC-24.

c. Characteristics.

(1) Type of modulation: Amplitude modulation.

(2) Bandwidth: 100 kilohertz.

(3) Power output: 2 to 20 watts.

(4) Antenna: UHF broadband type.

(5) Additional characteristics: See table 8-1.

Section II. RADIO TELETYPEWRITER SETS

8-4. RADIO TELETYPEWRITER SETS AN/GRC-46 AND AN/VRC-29

a. General. Radio teletypewriter (RATT) sets AN/GRC-46 (fig 8-3) and AN/VRC-29 (fig 8-5) are assemblies of transmitting, receiving, and teletypewriter equipment. Radio teletypewriter set AN/GRC-46 is arranged in a shelter that is normally mounted in a 3/4-ton vehicle (fig 8-4). Radio teletypewriter set AN/VRC-29 (fig 8-5) is arranged and mounted in an armored vehicle and does not have an independent shelter. Both radio teletypewriter sets are mobile and can be operated in forward areas of a combat zone. The radio teletypewriter sets are used for either separate or simultaneous transmission and reception of voice and radio teletype signals. Voice and continuous-wave (CW) signals may be furnished for either normal (one-way) or, with additional antenna equipment, duplex (tow-way) operation.

b. Major components.

(1) Transmitter T-195/GRC-19.

(2) Receiver R-392/URR.

(3) Teletypewriter set TT-98/FG.

(4) Teletypewriter reperforator-transmitter TT-76( )/GGC.

(5) Radio transmitter modulator MD-203/GR.

(6) Frequency-shift converter CV-278( )/GR.

(7) Interconnecting box J-2491/GR.

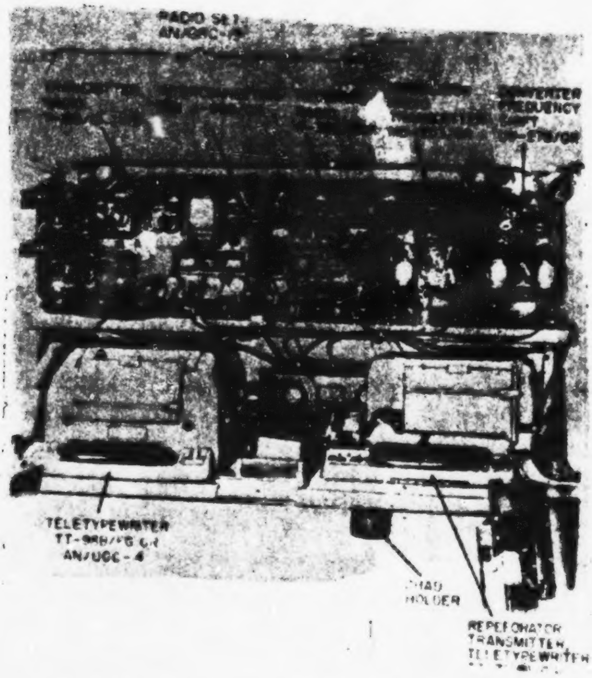
RADIO SET
AN/GRC-46
CONVERTER
FREQUENCY
SHIFT
CV-278/GR
TELETYPEWRITER
TT-98B/FG OR
AN/UGC-4
CHAD
HOLDER
REPERFORATOR
TRANSMITTER
TELETYPEWRITER

Figure 8-3. Radio teletypewritter set AN/GRC-46 C.

c. Characteristics.

(1) Type of installation: Vehicular (shelter, 3/4-ton truck).

(2) Type of modulation: Amplitude modualtion.

(3) Type of emission: Voice, CW or frequency-shift keyed (FSK) RATT, or voice and FSK simultaneously.

(4) Calibration: Calibration points in receiver at 100-KHz intervals.

(5) Power output (nominal): 100 watts.

(6) Antenna:

(a) Whip. 15 feet long (three MS-116's one MS-117, one MS-118).

(b) Doublet.

(7) Teletypewriter speed: 60 words per minute.

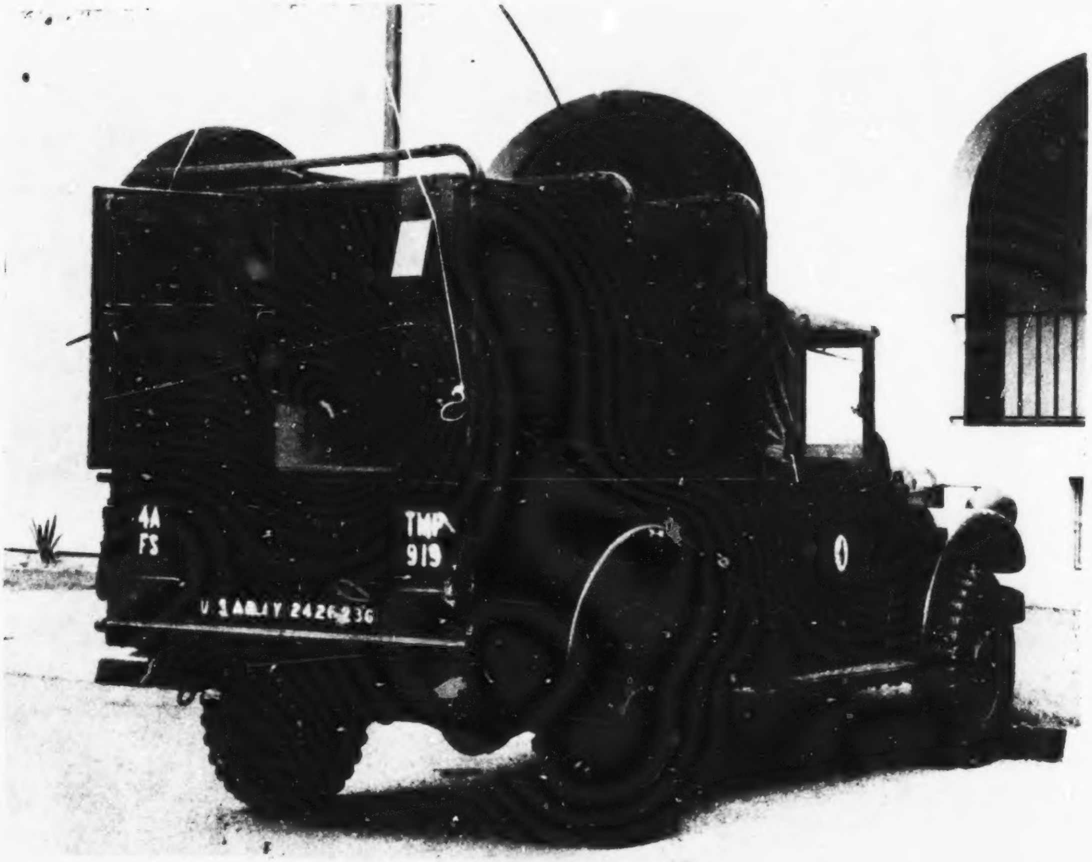

Figure 8-4. Shelter for radio teletypewriter set AN/GRC-46 A mounted on truck.

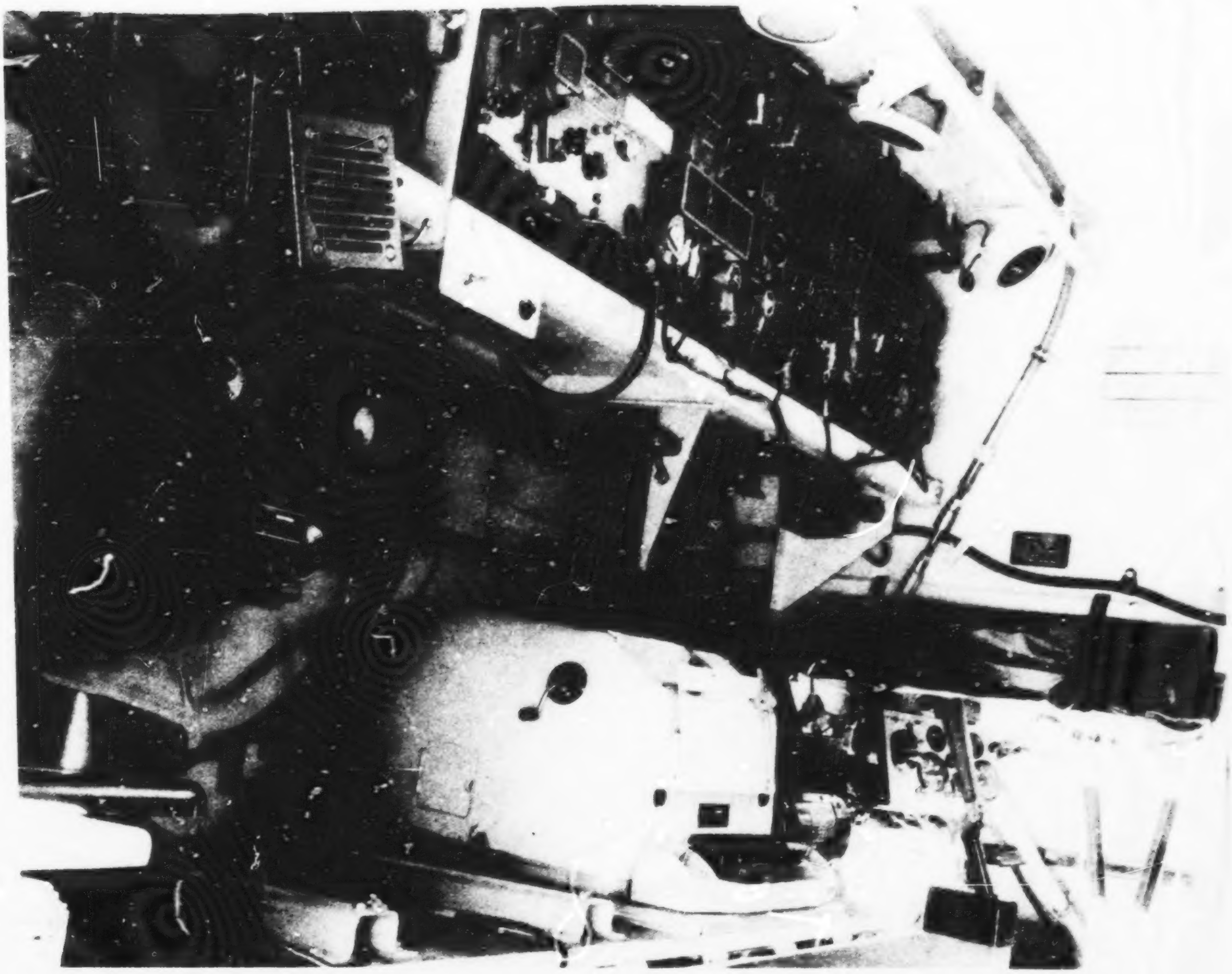

Figure 8-5. Radio teletypewriter set AN/VRC-29 (interior view).

b. Operation.

(1) To monitor incoming signals of different components, operate the MONITOR switch for the C-2298/VRC according to instructions in para 6-16c.

(2) Adjust the VOLUME control for the desired volume in the audio accessory.

Note. The adjustment of the VOLUME controls on the receiver and receiver-transmitters will affect the volume at the audio accessory when the MONITOR switch is in any position except ALL. Adjust the VOLUME controls on the receiver and receiver-transmitters for equal volume levels when the MONITOR switch is in a position other than ALL.

(3) To trnasmit on the first receiver-transmitter--

(a) Turn the MONITOR switch to ALL, A, or B.

(b) Press the PUSH-TO-TALK switch of the microphone connected to J802 of the control box and speak into the microphone.

(4) To transmit on the second receiver-transmitter--

(a) Turn the MONITOR switch to C.

(b) Press the PUSH-TO-TALK switch of the microphone connected to J802 of the control box and speak into the microphone.

(5) To use the intercom--

(a) If using a microphone connected to J803 (marked yellow), prss the PUSH-TO-TALK switch and speak into the microphone.

(b) If using a microphone connected to J802,

1. Turn the MONITOR switch to INT ONLY.

2. Press the PUSH-TO-TALK switch and speak into the microphone.

8-5. RADIO TRANSMITTER MODULATOR MD-203/GR

a. General. Radio transmitter modulator MD-203/GR (frequency-shift keyer) (fig 8-6) is a component of radio teletypwriter sets AN/VRC-29 and AN/GRC-46. While transmitting, a teletypewriter creates a pattern of DC impulses that are fed to the modulator. The DC impulses, through the action of the modulator, cause the frequency of the radio carrier wave to be shifted in a pattern corresponding to these impulses. Thus, the intelligence signal is imposed on the carrier wave and put in a receivable form.

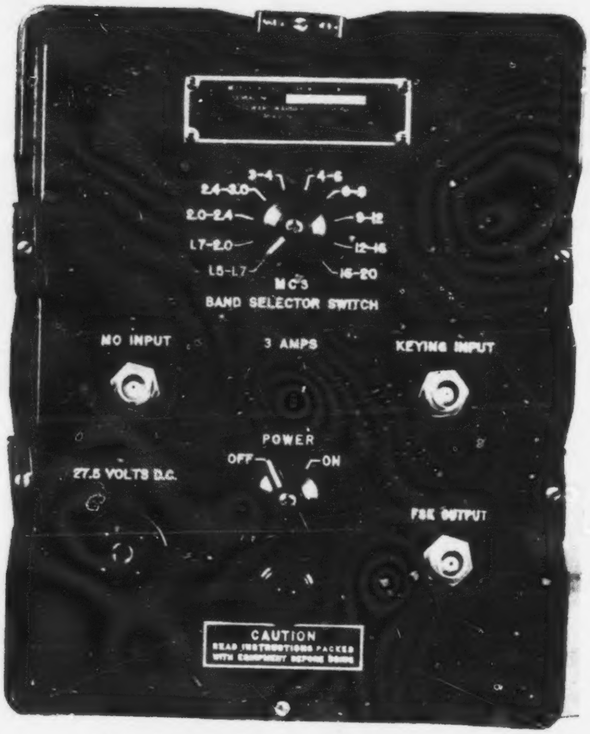
3-4
4-6
2.4-3.0
6-8
2.0-2.4
8-12
1.7-2.0
12-16
1.5-1.7
16-20
MCS
BAND SELECTOR SWITCH
MO INPUT
3 AMPS
KEYING INPUT
POWER
OFF
ON
27.5 VOLTS D.C.
FSK OUTPUT
CAUTION
READ INSTRUCTIONS PACKED WITH COMPONENT BEFORE USING

Figure 8-6. Radio transmitter modualtor MD-203/GR.

b. Control settings for operation.

(1) The POWER switch must be in the ON position.

(2) The BAND SELECTOR SWITCH must be set to the band of frequencies currently tuned on transmitter T-195/GRC-19.

8-6. FRQUENCY-SHIFT CONVERTER CV-278/GR

a. General. Frequency-shift converter CV-278/GR (fig 8-7) is part of radio teletypewriter sets AN/VRC-29 and AN/GRC-46. The converter is used for the reception of frequency-shift-keyed radio teletypewriter signals. The frequency-shift-keyed signals from the radio receiver are fed to the converter. The converter then converts the frequency-shift-keyed signals to DC impulses and feeds these impulses into the receiving teletypwriter.

b. Control settings for operation.

(1) The POWER switch must be in the ON position.

(2) The SERVICE switch must be in the NOR position.

Note. The SIGNAL INPUT meter indicates input signal level. Scale divisions represent arbitrary values. The DISCRIMINATION meter needle should oscillate slightly across the center (zero) point during reception.

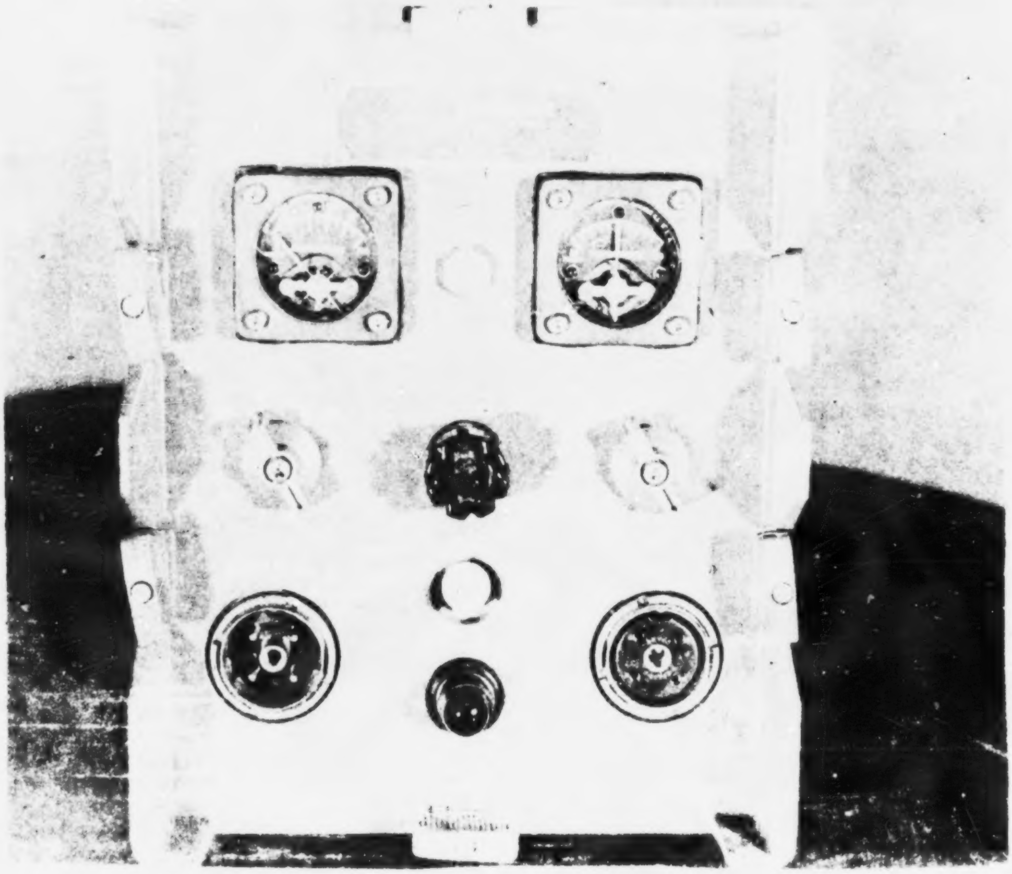

Figure 8-7. Frequency-shift converter CV-278/GR.

8-7. TELETYPEWRITER SET TT-98

a. General. Teletypewriter set TT-98 is a page-printing, keyboard-sending teletypewriterdesigned for use on direct-wire, carrier, or radio teletype circuits. It is desinged to operate at 60 words per minute; however, it is capable of operating at 66, 75, or 100 words per minute. The operator can type 72 characters per line. A bell signals the operator when he is nearing the end of the line. Page-printed copies (and cabon copies as desired) of all messages sent and received are provided.

b. Use with radio teletypewriter sets. Keyboard sending (fig 8-9) is not often used with radio-teletypwriter sets AN/VRC-29 and AN/GRC-46 because these sets have tape-punching and tape-sending equipment. (See teletypewriter TT-76/GGC, figure 8-10.)

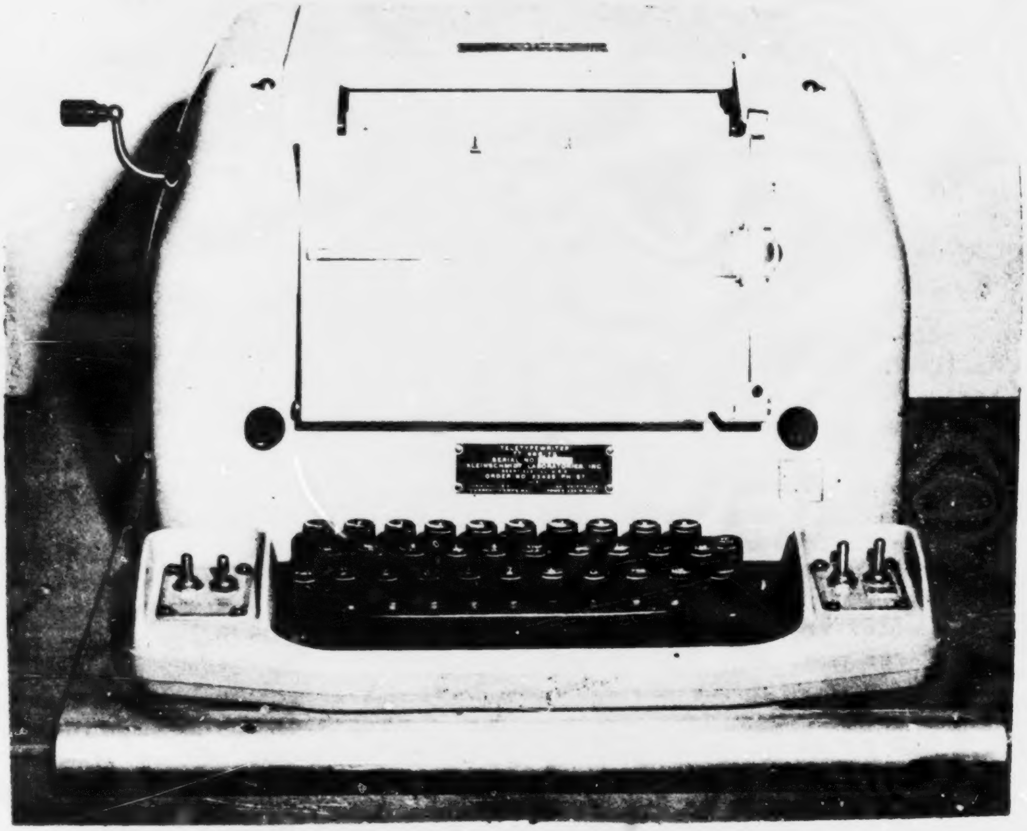

Figure 8-8. Teletypewriter set TT-98/FG.

8-8. TELETYPEWRITER REPERFORATOR-TRANSMITTER TT-76/GGC

Teletypwriter reperforator-transmitter TT-76/GGC (fig 8-9) is part of radio teletypewriter sets AN/VRC-29 and AN/GRC-46. The keyboard of this teletypewriter is used to perforate a 7/8-inch paper tape and print along the length of the tape a readable copy of the message.

The tape, in turn, can then be sent through an automatic tape-sending device, the transmitter distributor which is also part of this teletypewriter. As the taped message is transmitted, a printed copy of the message appears simultaneously on the teletypewriter set TT 98-FG. Controls of the TT-76/GGC can also be arranged to punch a tape of any received traffic. The tape expedites the relaying of messages.

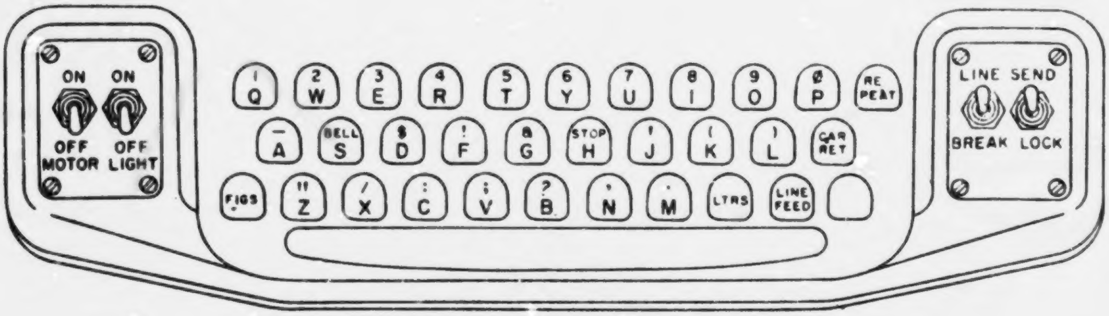
ON
ON
OFF
OFF
MOTOR
LIGHT
1 Q
2 W
3 E
4 R
5 T
6 Y
7 U
8 I
9 O
Ø P
RE PEAT
— A
BELL S
$ D
! F
& G
STOP H
' J
(K
) L
CAR RET
FIGS
" Z
/ X
: C
; V
? B
, N
. M
LTRS
LINE FEED
LINE
SEND
BREAK
LOCK

Figure 8-9. Teletypewriter keyboard.

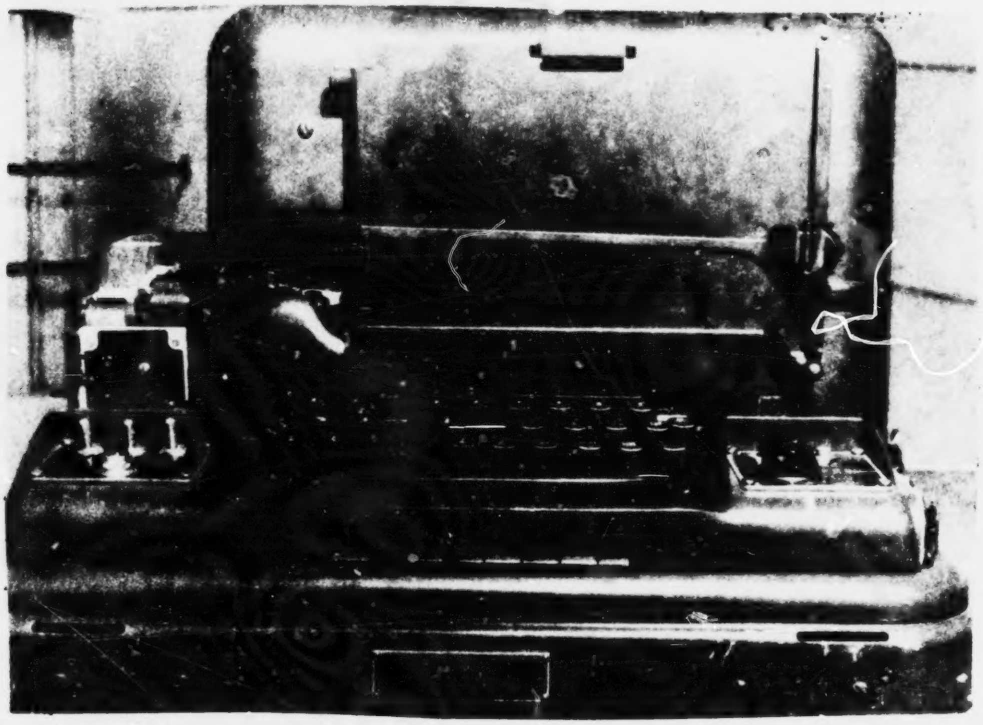

Figure 8-10. Teletypewriter reperforator-transmitter TT-76/GGC.

8-9. INTERCONNECTING BOX J-2491/GR

Interconnecting box J-2481/GR (fig 8-11) serves as a junction box and control for all the radio and teletype equipment of radio teletypewriter set AN/GRC-46. The MAIN POWER control is a master power switch for all the equipment. The meter on the left indicates teletypwriter operating currents. The meter on the right reflects primary battery voltage. Other ON-OFF controls are self-explanatory.

PHOTO NOT AVAILABLE

Figure 8-11. Interconnecting box J-2491/GR.

Section III. ANCILLARY ANTENNA EQUIPMENT

8-10. AUXILIARY ANTENNA GROUPS AN/GRA-4, AN/GRA-12, AND AN/GRA-50

a. General. Antenna groups AN/GRA-4 (fig 8-12), AN/GRA-12 (fig 8-13), and AN/GRA-50 (fig 8-14) are portable half-wave antenna assemblies designed for the transmission and reception of radio signals.

(1) The AN/GRA-4 antenna is used in conjunction with any radio set that has a transmitter output of less than 100 watts and a characteristic impedance of 72 or 500 ohms.

(2) The AN/GRA-12 antenna is used with any radio set that has a transmitter output of 500 watts or less and a characteristic impedance of 72 or 500 ohms.

(3) The AN/GRA-50 antenna is used with any radio set that has a trans-mitter output of 430 watts or less and a characteristic impedance of 50 ohms. The AN/GRA-50 is primarily used with radio sets AN/GRC-19, AN/GRC-46, AN/GRC-142, and AN/GRC-122.

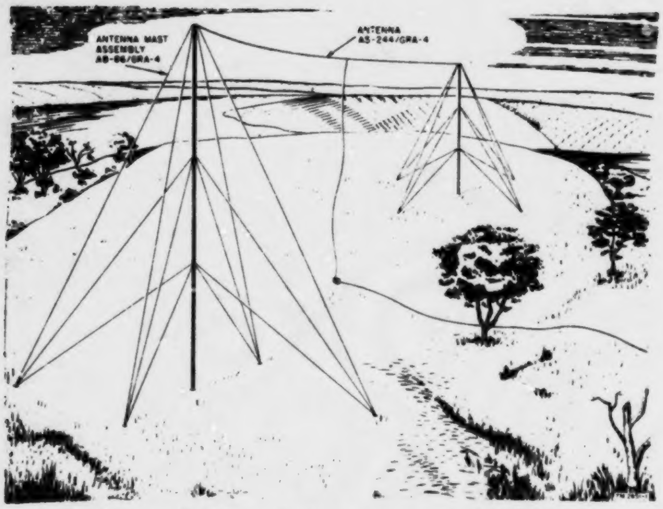
ANTENNA MAST
ASSEMBLY
AB-86/GRA-4
ANTENNA
AS-244/GRA-4

Figure 8-12. Antenna group AN/GRA-4.

b. Characteristics of antenna group AN/GRA-4.

(1) Power input: Up to 100 watts.

(2) Frequency range: 1.5 to 18 megahertz.

(3) Weight: 169 pounds.

(4) Antenna: Half-wave.

(5) Impedance: 72 or 500 ohms.

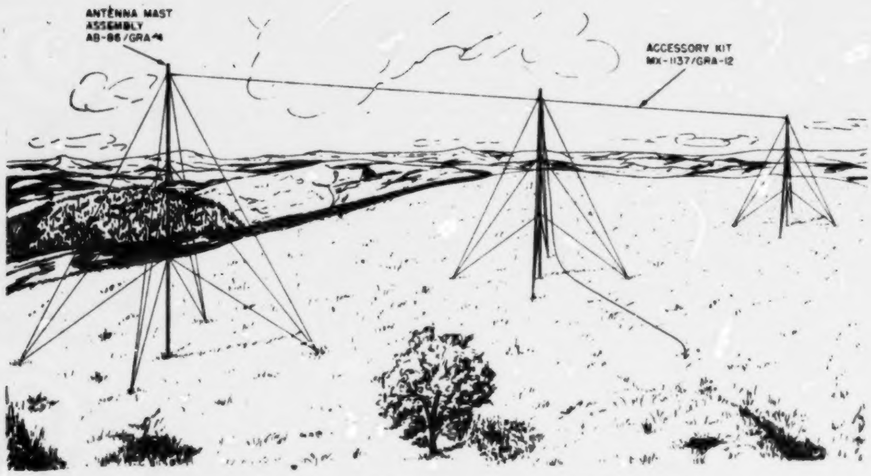
ANTENNA MAST
ASSEMBLY
AB-86/GRA-4
ACCESSORY KIT
MX-1137/GRA-12

Figure 8-13. Antenna group AN/GRA-12.

c. Characteristics of antenna group AN/GRA-12.

(1) Power input: Up to 500 watts.

(2) Frequency range: 1.5 to 18 megahertz.

(3) Weight: 229 pounds.

(4) Antenna: Center-fed hertz (half-wave).

(5) Impedance: 52 ohms.

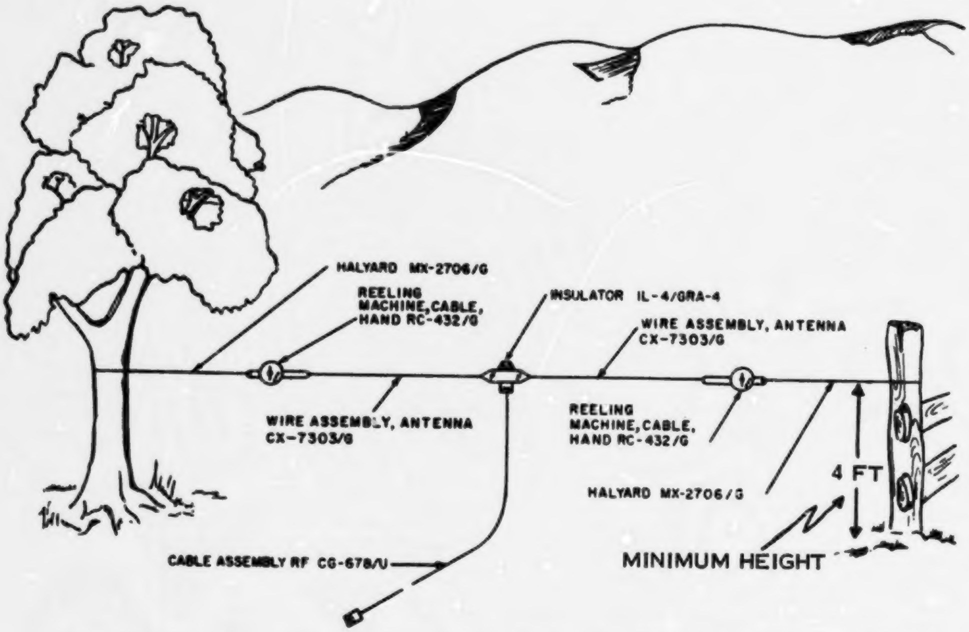
HALYARD MX-2706/G
REELING MACHINE, CABLE, HAND RC-432/G
INSULATOR IL-4/GRA-4
WIRE ASSEMBLY, ANTENNA CX-7303/G
WIRE ASSEMBLY, ANTENNA CX-7303/G
REELING MACHINE, CABLE, HAND RC-432/G
4 FT
HALYARD MX-2706/G
CABLE ASSEMBLY RF CG-678/U
MINIMUM HEIGHT

Figure 8-14. Antenna group AN/GRA-50, typical installation.

d. Characteristics of antenna group AN/GRA-50.

(1) Power input: Up to 430 watts.

(2) Frequency range: 1.5 to 30 megahertz.

(3) Weight: 12 pounds.

(4) Antenna: Center-fed hertz (half-wave).

(5) Impedance: 50 ohms.

8-11. SELECTING ANTENNAS

The basic concepts of good military radio communications, as well as the operating characteristics of each type of antenna, should be taken into account in the selection of antennas.

8-12. SITING ANTENNAS

a. General. Certain conditions must be taken into consideration in the choice of a location for setting up the mast assembly and antenna. Location of the distant station should be taken into account. When communication is to be established with two or more distant stations, the antenna should be locatedin a position favorable to the station most difficult to recive.

b. Vertical antenna. The ideal location for erecting a vertical antenna is the center of a plateau having no natural or artifical obstructions nearby. When possible, a spot of dry ground with good drainage should be selected to provide a firm base for the stakes.

c. Horizontal antenna. If the location of the communication center is not suitable for a vertical antenna, a horizontal antenna is used. It should be located in a clearing and should be oriented in the direction at which it takes fullest advantage of its radiation pattern. As the radiation pattern of the half-wave antenna is broadside to the wire, the antenna should be erected with the wire broadside to the distant station. When two or more stations must be considered, the antenna should be oriented so that the wire is broadside to the station most difficult to receive. Both location and orientation should be determined on the basis of the location of the distant stations when possible.

Notes.

AVAILABLE

Notes.

CHAPTER 9

SINGLE SIDEBAND (AM) RADI EQUIPMENT

Section I. RADIO SET AN/GRC-106 AND AN PRC-74B

9-1. RADIO SET AN/GRC-106

Radio set AN/GRC-106 (fig 9-1) is a high-frequency, single-sideband (SSB) radio receiving-transmitting set. It consists of receiver-transmitter RT-662/GRC (fig 9-2) or RT-834/GRC (fig 9-2A), radiofrequency amplifier AM-3349/GRC-106 (fig 9-3), mounting MT-3140/GRC-106, a standard 15-foot whip antenna, antenna group AN/GRA-50, and an installation kit. Ancillary equipment and cording are shown in figure 9-4.

a. Characteristics of receiver-transmitter RT-662/GRC.

(1) Number of electron tubes: Two.

(2) Number of transistors: 140.

(3) Types of transmission: Upper-sideband (USB) voice, upper-sideband compatible AM, on conintuous-wave.

(4) Types of reception: Upper-sideband compatible and conventional double-sideband AM an continuous-wave.

(5) Type of control: Crystal-controlled synthesizers reference to a highly stable 5-megahertz internal standard.

(6) Frequency range: 2.0 to 29.999 MHz.

(7) Channels: 28,000 with 1000-Hz channel spacing.

(8) Power requirements: 27 volts DC ±3.

b. Characteristics of radiofrequency amplifier AM-3349/GRC-106.

(1) Number of electron tubes: Three.

(2) Number of transistors: 10.

(3) Power output:

(a) CW, 200 watts average.

(b) USB voice and compatible AM voice, 400 watts peak envelope power (PEP).

127

(4) Antennas:

(a) Whip. 15 feet long (three MS-116's one MS-117, and one MS-118).

(b) Doublet. AN/GRA-50 (para 8-10d).

c. Characteristics of receiver-transmitter RT-834/GRC.

(1) Number of electron tubes: Two.

(2) Number of transistors: 151.

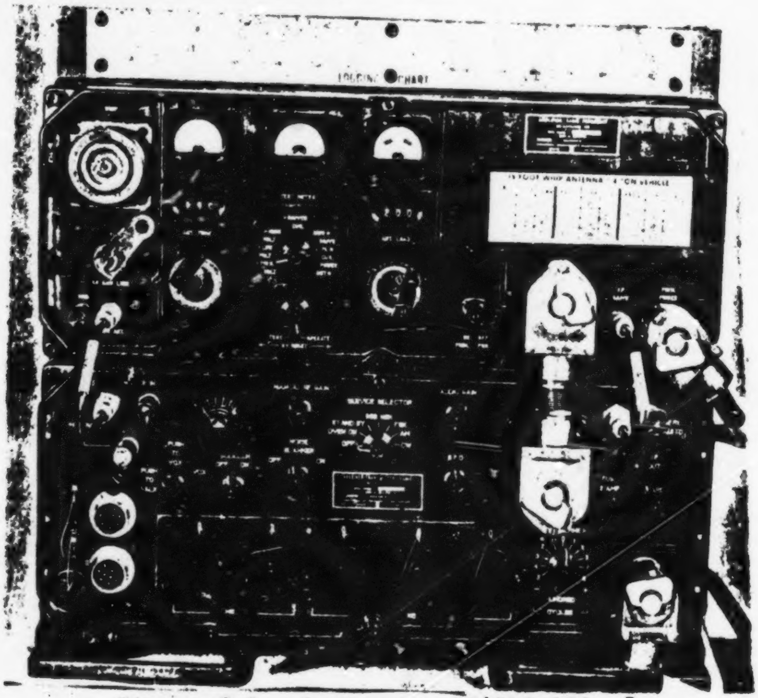

Figure 9-1. Radio set AN/GRC-106.

(3) Types of transmission: USB voice, upper-sideband compatible AM, CW, FSK, and NSK.

(4) Type of reception: USB compatible and conventional double-sideband AM, CW.

(5) Type of control: Crystal-controlled synthesizers referenced to a highly stable 5-megahertz internal standard.

(6) Power requirements: 27 volts direct current ±3.

(7) Frequency range: 2.0 - 29.9999 MHz.

(8) Channels: 280,000 with 100-Hz channel spacing.

128

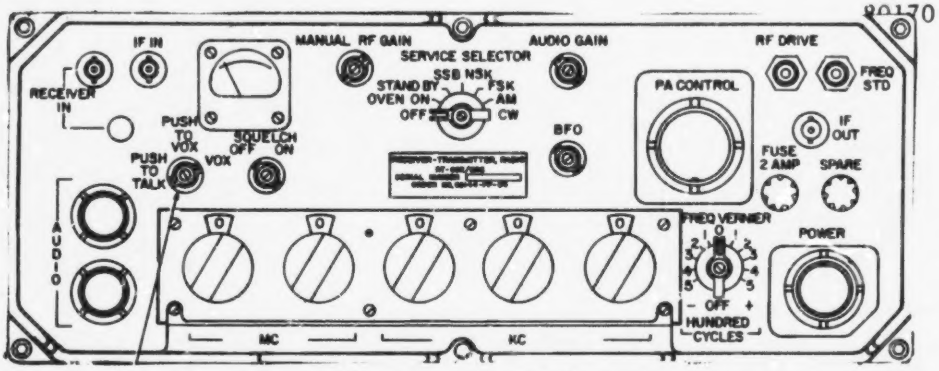
IF IN
RECEIVER IN
MANUAL RF GAIN
SERVICE SELECTOR
SSB NSK
STAND BY
FSK
OVEN ON
AM
OFF
CW
AUDIO GAIN
RF DRIVE
FREQ STD
PA CONTROL
IF OUT
PUSH TO VOX
SQUELCH
OFF
ON
PUSH TO TALK
VOX
BFO
FUSE 2 AMP
SPARE
AUDIO
FREQ VERNIER
OFF
HUNDRED CYCLES
POWER
MC
KC

Figure 9-2. Receiver-transmitter, radio RT-834/GRC controls, indicators, and connectors.

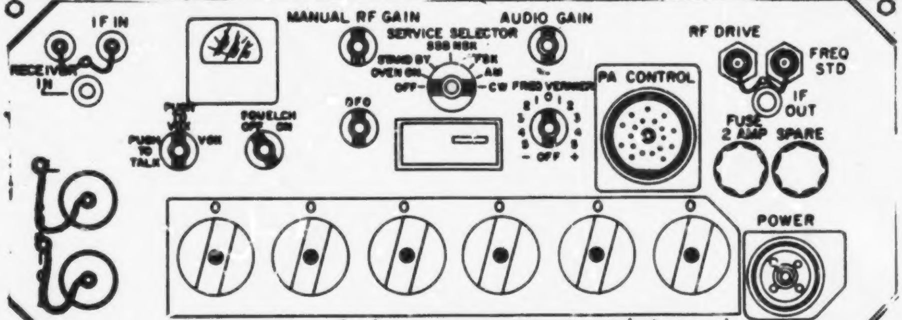
IF IN
RECEIVER IN
MANUAL RF GAIN
SERVICE SELECTOR
SSB NSK
STAND BY
FSK
OVEN ON
AM
OFF
CW
AUDIO GAIN
RF DRIVE
FREQ STD
FREQ VERNIER
PA CONTROL
IF OUT
FUSE 2 AMP
SPARE
BFO
PUSH TO VOX
SQUELCH
OFF
ON
PUSH TO TALK
VOX
POWER
MHz
KHz
100 Hz

Figure 9-2A. Receiver-transmitter, radio RT-834/GRC controls, indicators, and connectors.

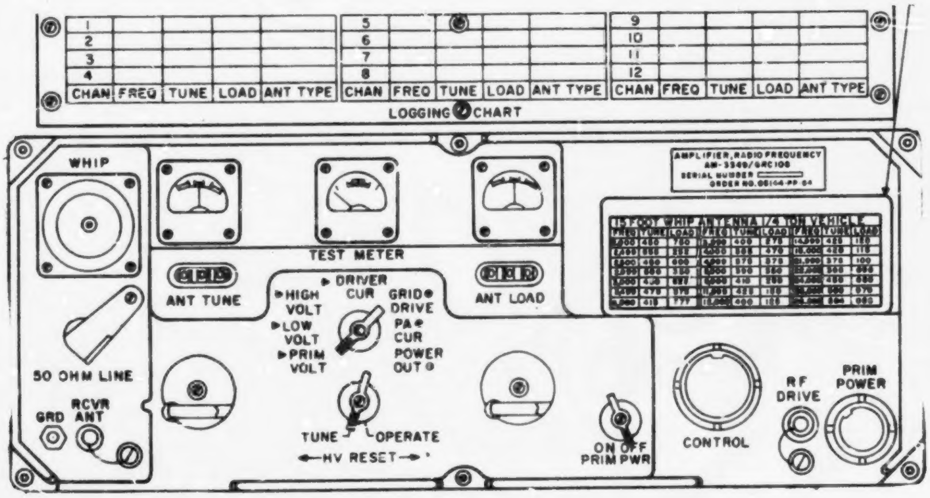
CHAN
FREQ
TUNE
LOAD
ANT TYPE
1
2
3
4
5
6
7
8
9
10
11
12
LOGGING CHART
AMPLIFIER, RADIO FREQUENCY
AM-3349/GRC106
SERIAL NUMBER
WHIP
TEST METER
ANT TUNE
ANT LOAD
DRIVER CUR
HIGH VOLT
GRID DRIVE
LOW VOLT
PA CUR
PRIM VOLT
POWER OUT
50 OHM LINE
GRD
RCVR ANT
TUNE
OPERATE
HV RESET
ON OFF
PRIM PWR
CONTROL
RF DRIVE
PRIM POWER

Figure 9-3. Amplifier, radiofrequency, AM-3349/GRC-106(*) controls, indicators and connectors.

AN/GRC-106 FAMILY

	RT-662	AM-3349	AM-3399	MD-522	TT-76	AN/UGC-4	TT-4A	MOUNTED IN
AN/GRC-106	1	1						APC M557 1/4-3/4-ton
AN/GRC-142	1	1		1	1	1		3/4-ton
AN/GRC-122	2	1		1	1	2		3/4-ton
AN/GRC-108	2		1	1	1	2		2-1/2-ton
AN/VSC-2	1	1		1			1	1/4-ton
AN/VSC-3	1	1		1	1	1		APC

Figure 9-4. Block diagram of single sideband radio equipment.

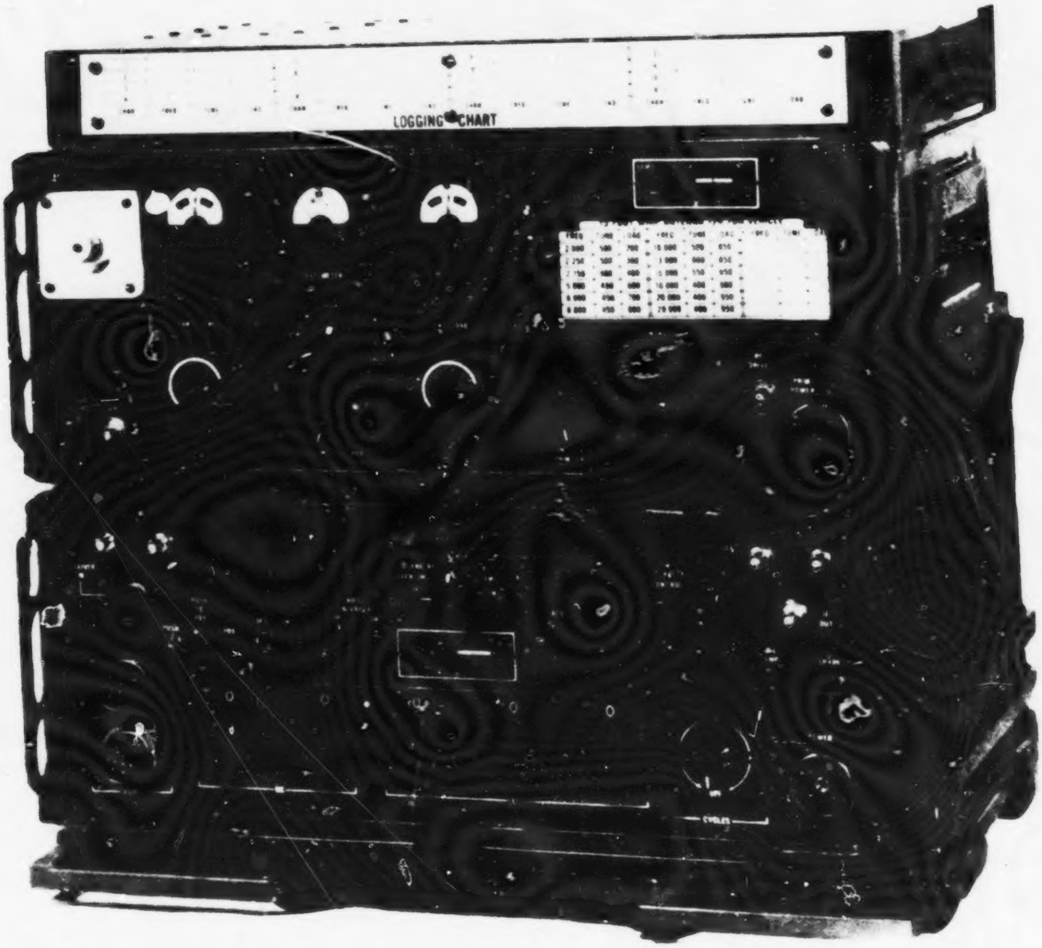

Figure 9-4a. Radio Set AN/GRC-106

9-2. RADIO SET AN/PRC-74B

a. General. Radio set AN/PRC-74B (fig 9-5) is a single-sideband receiver-transmitter designed for use as a manpack set in areas where direct line-of-sight communication is not possible. The difference between the PRC-74B and PRC-74C is the handles on outer case, on the C-model Hz is listed on the tuning controls instead of C and the internal components.

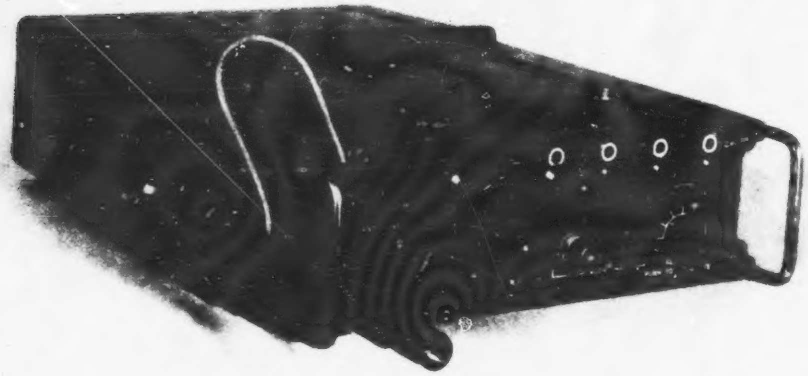

Figure 9-5. Radio set AN/PRC-74B.

b. Components.

(1) Receiver-transmitter. The receiver-transmitter is fully transistorized and operates on a single frequency. Frequency range - 2,000 to 17.999 MKZ in 1.0 KHZ steps. Power output - 15 watts peak envelope power.

(2) Power source. During normal operation, the radio set is man-carried and is operated from either a dry or wet battery pack. Two BA-4386 batteries (fig 9-6), connected in parallel, are used in the dry battery pack. The wet battery pack is a rechargeable nickel-cadmium battery. Power supply PP-4515 is used with the set when it is installed in a vehicle. This power supply can also be used to recharge the wet-cell battery. Power requirements: 10.5 to 17.0 volts DC.

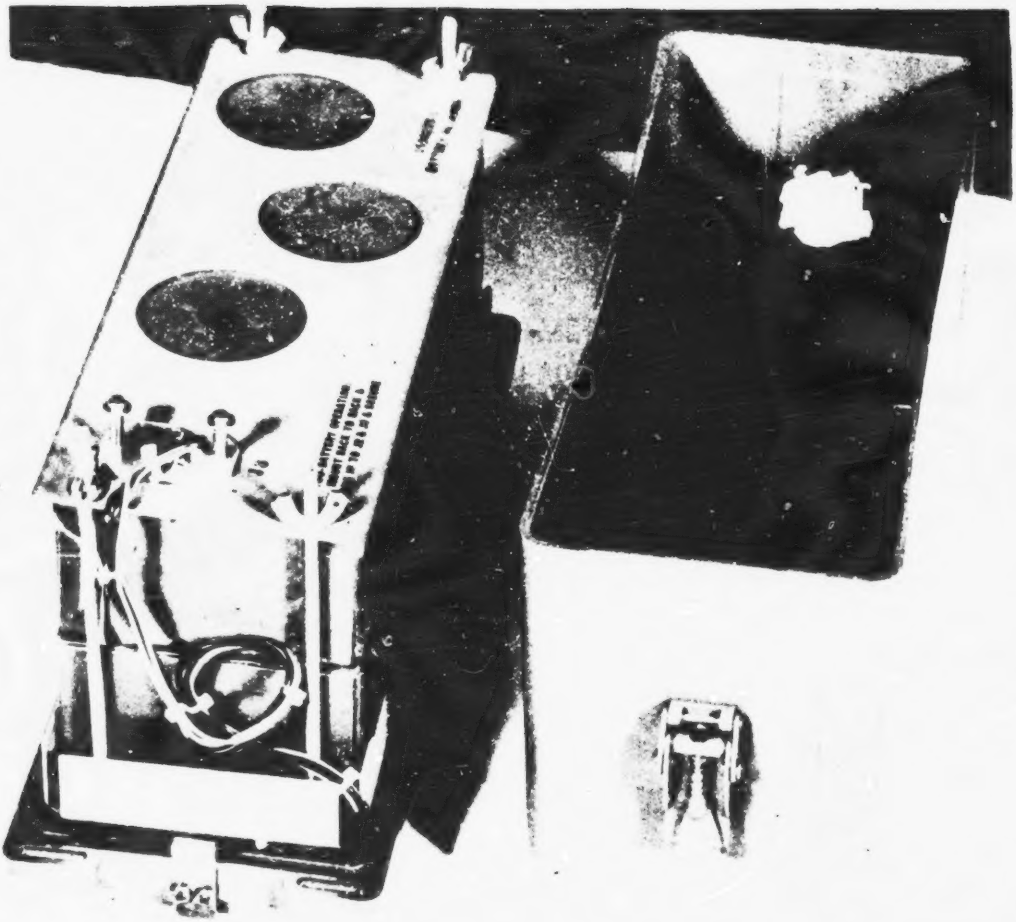

Figure 9-6. Dry battery pack.

(3) Antennas. The radio set can be operated with a whip antenna or various configurations of a wire antenna (fig 9-7). The whip antenna is issued with a mounting bracket, which attaches to the radio set, and an antenna support base. The antenna kit consists of two reels of antenna wire, two reels of Dacron cord, and a dipole fixture.

Whip antenna: 25 miles (40 km)

Dipole antenna: Increases transmitting distance several hundred miles by use of the skywave.

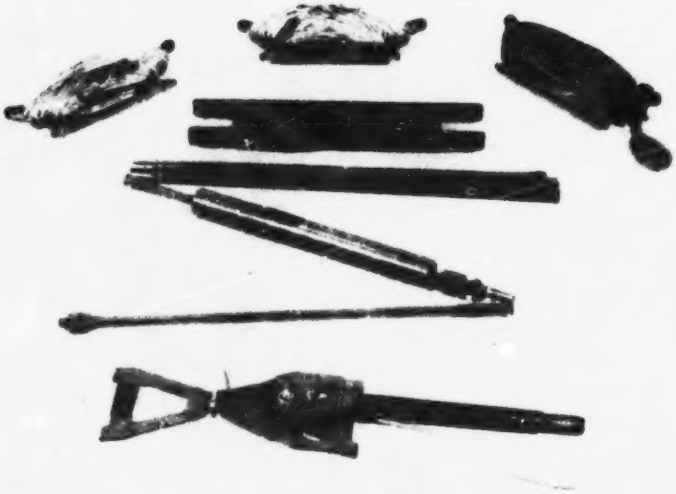

Figure 9-7. Antenna kit.

(4) Accessory equipment. Accessory equipment (fig 9-8) includes a headset, microphone, and telegraph key. A special-purpose cable permits the use of the radio set with an automatic keyer for transmission of Morse code at the rate of 300 words per minute. Antennas and accessories are stored in a canvas bag when they are not in use.

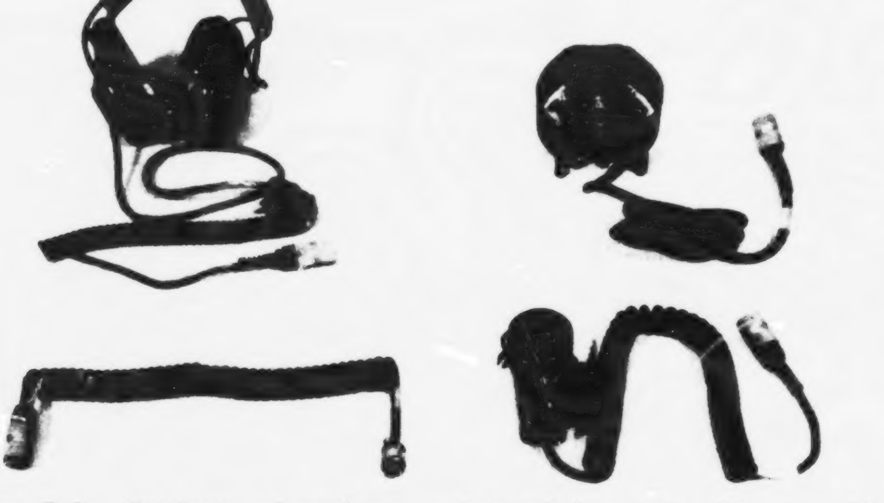

Figure 9-8. Headset, microphone, telegraph key and cable-assembly, special purpose CX-10239.

c. Characteristics.

(1) Modulation modes. The AN/PRC-74B is capable of transmitting upper-sideband suppresed-carrier voice or continuous-wave.

(2) Frequency range. The AN/PRC-74B operates in the frequency range of 2.000 to 17.999 megahertz.

(3) Operating channels. This set can be operated on any one of 16,000 selectively tuned channels, spaced in 1-kilohertz increments.

(4) Power output. The nominal power output is 15 watts peak envelope power.

(5) Operating range. Since this set operates at the low end of the high-frquency spectrum, signals are propagated by both groundwave and skywave. Used with a whip antenna, this set will provide reliable communication up to 40 km. The operating range can be extended to several hundred miles by selection of the proper frequency and by use of the dipole antenna.

d. Installation.

(1) Battery box. Remove the cover from the battery box. Install two batteries BA-386 and replace the cover.

(2) Receiver-transmitter. Mate the connector on the bottom of the receiver-transmitter with the connector on the battery box. Engage and lock the latches on each side of the receiver-transmitter. Connect the headset and microphone.

(3) Whip antenna. The whip antenna is the least effective of the three antennas issued with the set; however, it can be erected quickly and requires no support. It is mounted on a swivel that permits the radio set to be flat on the ground and the antenna to be in an upright position.

(4) Slant wire antenna. The slant wire antenna is much more effective than the whip antenna. It requires the use of the dipole antenna wire and an antenna support. It is used when greater range is necessary and when time or conditions do not allow the erection of a dipole antenna.

(5) Dipole antenna. The dipole antenna is the most effective antenna and, time and tactical circumstances permitting, should be used in preference to either the whip or the slant wire antenna. A dipole antenna is usually erected between two supports. Supports are not provided with this equipment and it is not always possible to find two supports that are properly spaced and oriented. If only one support is available or if the terrain prohibits the use of two supports, a one-support dipole should be used. For both the dipole and slant wire antennas, the most effective transmitting and receiving direction is broadside to the line of the wire.

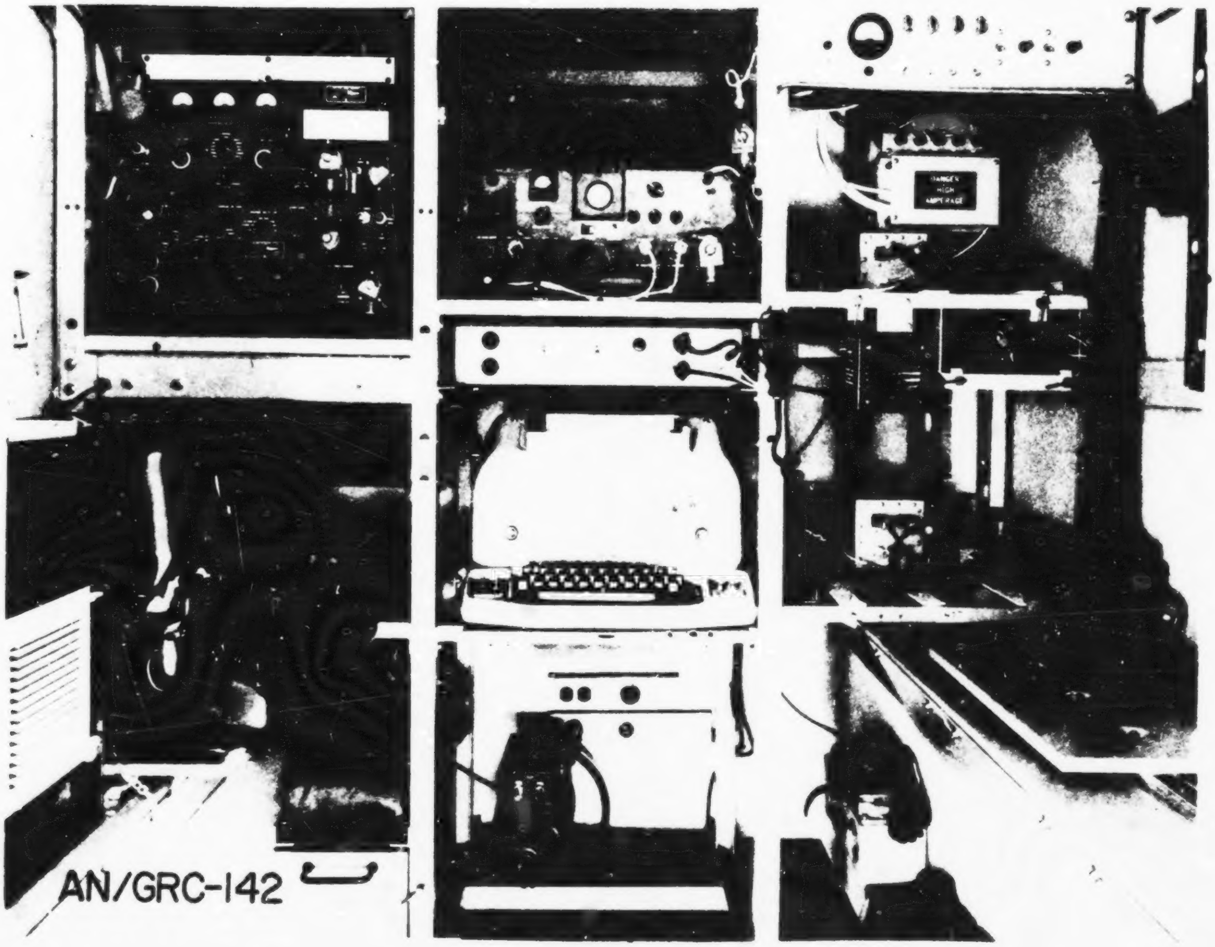
DANGER
HIGH
AMPERAGE
AN/GRC-142

Figure 9-9. Radio teletypewriter set AN/GRC-142 (less power supply).

Section II. RADIO TELETYPEWRITER SETS AN/GRC-142, AN/GRC-122, AN/VSC-3, AND AN/VSC-2

9-3. RADIO TELETYPEWRITER SETS AN/GRC-142

a. General. Radio teletypewriter set AN/GRC-142 (fig 9-9) is installed in the electrical equipment shelter S-250 ( )/G, which is mounted on a 5/4-ton vehicle. The radio components are the same as those of radio set AN/GRC-106 (para 9-1) with additional equipment provided for radio teletypewriter communication. The AN/GRC-142 is capable of providing a half-duplex circuit using upper-sideband compatible AM, continuous-wave, frequency-shift-keyed, and narrow frequency-shift-keyed signals. Primary power is provided by the vehicle that is equipped with a high-capacity (100-ampere) 28-volt electrical system. The AN/GRC-142 was designed to replace radio teletypwriter set AN/GRC-46.

b. Major components.

(1) Reciver-transmitter RT-662( )GRC or RT-834/GRC.

(2) Radio frequency amplifier AM-3349( )GRC-106.

(3) Radio teletypewriter modem unit MD-522/GR.

(4) Teletypewriter set TT-98.

(5) Teletypwriter reperforator-transmitter TT-76( ) GGC.

(6) Electrical equipment shelter S-318( )/G.

(7) Rotary converter.

c. Characteristics of receiver-transmitter RT-662/GRC and RT-834/GRC.

(1) Number of electron tubes: Two.

(2) Number of transistors: 140 (RT-662) and 151 (RT-834).

(3) Types of transmission: USB voice, upper-sideband compatible AM, CW, FSK, and NSK.

(4) Type of reception: USB compatible and conventional double-sideband AM, CW, FSK, and NSK.

(5) Type of contol: Crystal-controlled synthesizers referenced to a highly stable 5-megahertz internal standard.

(6) Power requirements: 28.5 volts DC.

d. Characteristics of radio frequency amplifier AM-3349( )/GRC-106.

(1) Number of electron tubes: Three.

(2) Number of transistors: 10.

(3) Power output:

(a) CW and RATT (FSK and NSK), 200 watts average.

(b) USB voice and compatible AM voice, 400 watts, peak envelope power.

(4) Planning range: 80 km, groundwave; up to 2, 400 km, skywave under suitable propagation conditions and with the proper choice of frequencies and antennas.

(5) Power requirements: 28.5 volts DC.

(6) Types of antennas:

(a) Whip. 15 feet long (three MS-116's, one MS-117, and one MS-118).

(b) Doublet. AN/GRA-50 (para 8-10d).

e. Characteristics of radio teletypewriter modum unit MD-522/GR. (Fig 9-10, 9-11, 9-12.)

(1) FSK: Frequency shift, 850 hertz.

(2) NSK: Frequency shift, 85 hertz.

(3) Power requirements: 28.5 volts DC.

f. Characteristics of teletypewriter set TT-98. Same as those of the AN/UGC-4 (para 8-7).

g. Characteristics of teletypewriter reperforator-transmitter TT-76 ( ) GGC. See paragraph 8-8.

h. Rotary converter. The rotary converter converts 28.5 volts DC to 115 volts AC at 60 hertz for the teletypewriter equipment.

9-4. RADIO TELETYPEWRITER SET AN/GRC-122

Radio teletypewriter set AN/GRC-122 (fig 9-13) radio teletypewriter set AN/GRC-142 are similar except that the AN/GRC-122 includes an additional RT-662 or RT-834, teletypewriter set TT-98, and rotary converter. The AN/GRC-122 has the additional capability of providing full-duplex operation in all types of service.

9-5. RADIO TELETYPEWRITER SET AN/VSC-3

Radio teletypewriter set AN/VSC-3 (fig 9-14) and radio teletypewriter set AN/GRC-142 are identical except that the AN/VSC-3 is arranged and mounted in an armored vehical and does not have an independent shelter.

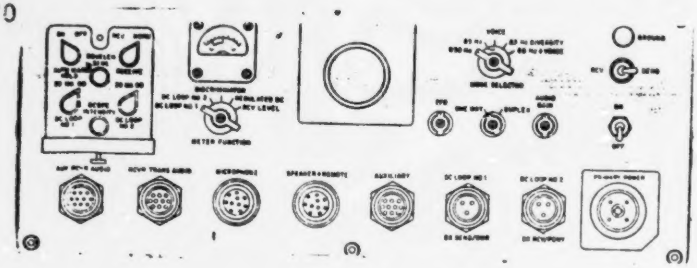

Figure 9-10. Modem MD-522A/GRC.

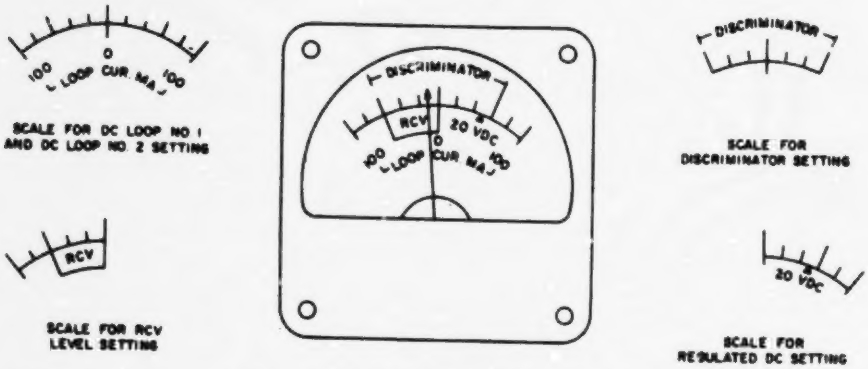
100
0
LOOP CUR. MA
100
SCALE FOR DC LOOP NO 1
AND DC LOOP NO. 2 SETTING
DISCRIMINATOR
RCV
20 VDC
0
100
LOOP CUR MA
100
DISCRIMINATOR
SCALE FOR
DISCRIMINATOR SETTING
RCV
SCALE FOR RCV
LEVEL SETTING
20 VDC
SCALE FOR
REGULATED DC SETTING

Figure 9-11. Modem MD-522 (A)/GRC meter scale functions.

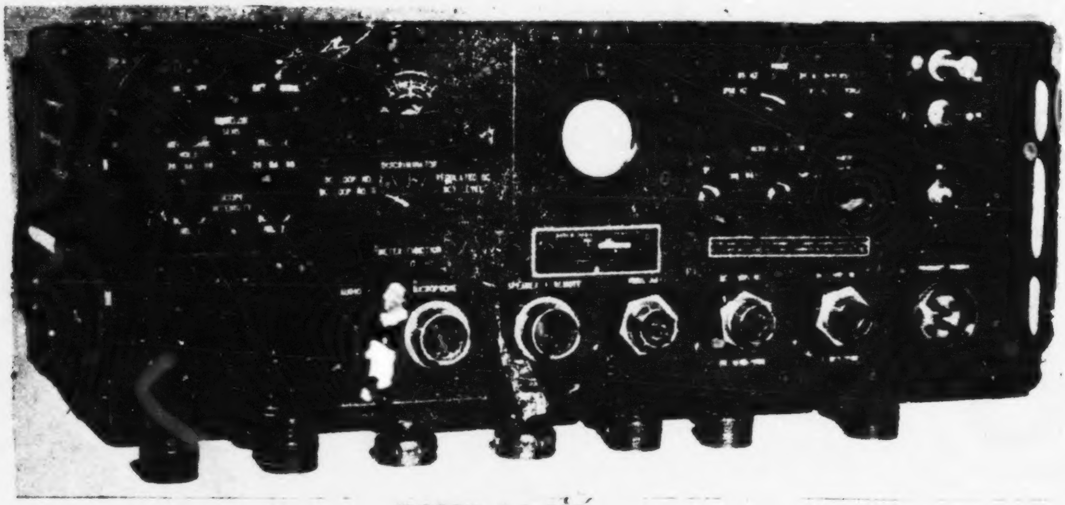
MODEM MD-522

Figure 9-12. Modem MD-522(A)/GRC scope traces for proper and improper tuning of associated radio receiver.

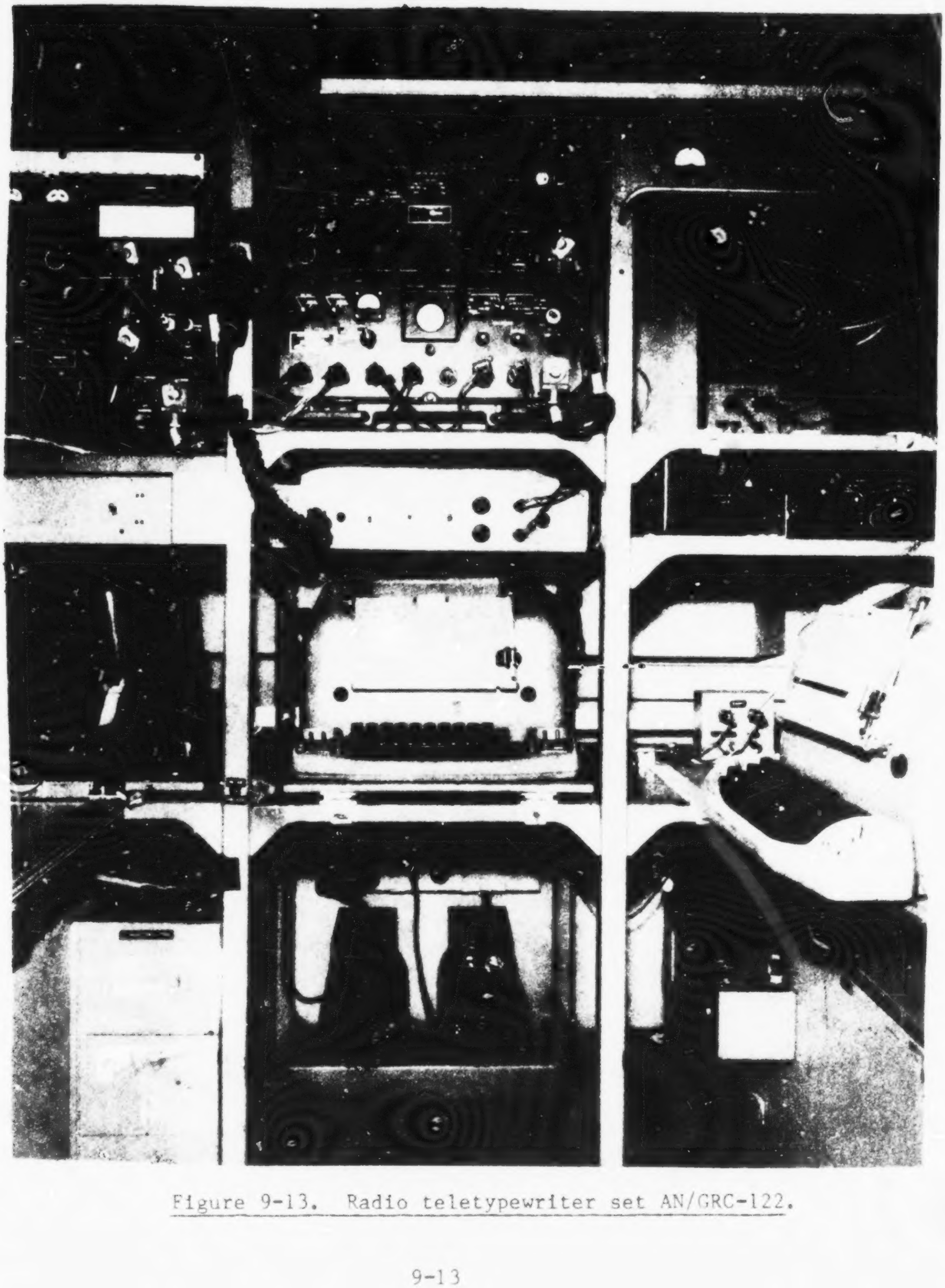

Figure 9-13. Radio teletypewriter set AN/GRC-122.

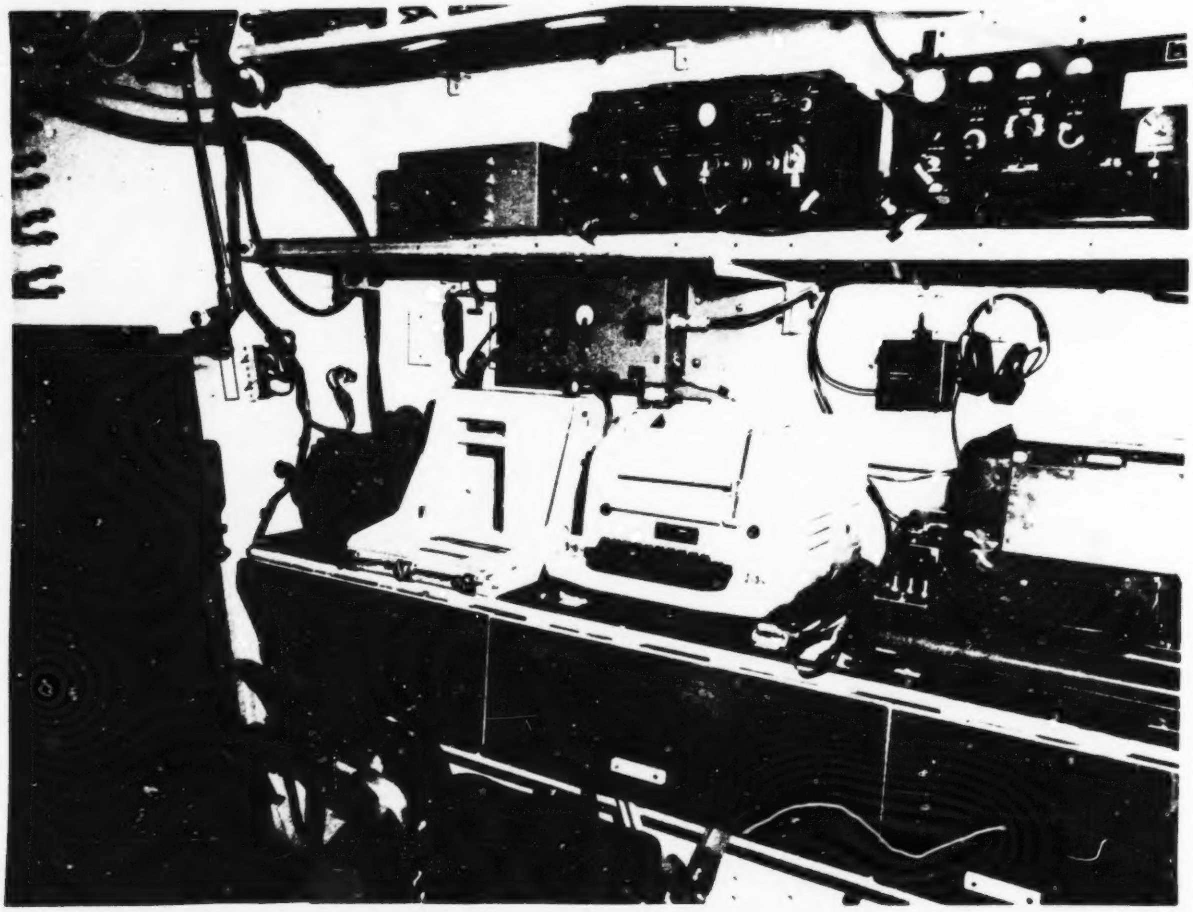

Figure 9-14. Radio teletypewriter set AN/VRC-3.

9-6. RADIO TELETYPEWRITER SET AN/VSC-2

Radio teletypewriter set AN/VSC-2 (fig 9-15) is a vehicular-mounted set installed in a 1/4-ton vehicle. The radio components of the AN/VSC-2 are the same as those of radio set AN/GRC-106 (para 9-1) with additional equipment provided for radio teletypewriter communication. The AN/VSC-2 has the same characteristics and facilities as the AN/GRC-142 except that it uses a teletypewriter set TT-4C instead of the teletypewriter set TT-98 and reperforator-transmitter TT-76 ( ) GGC.

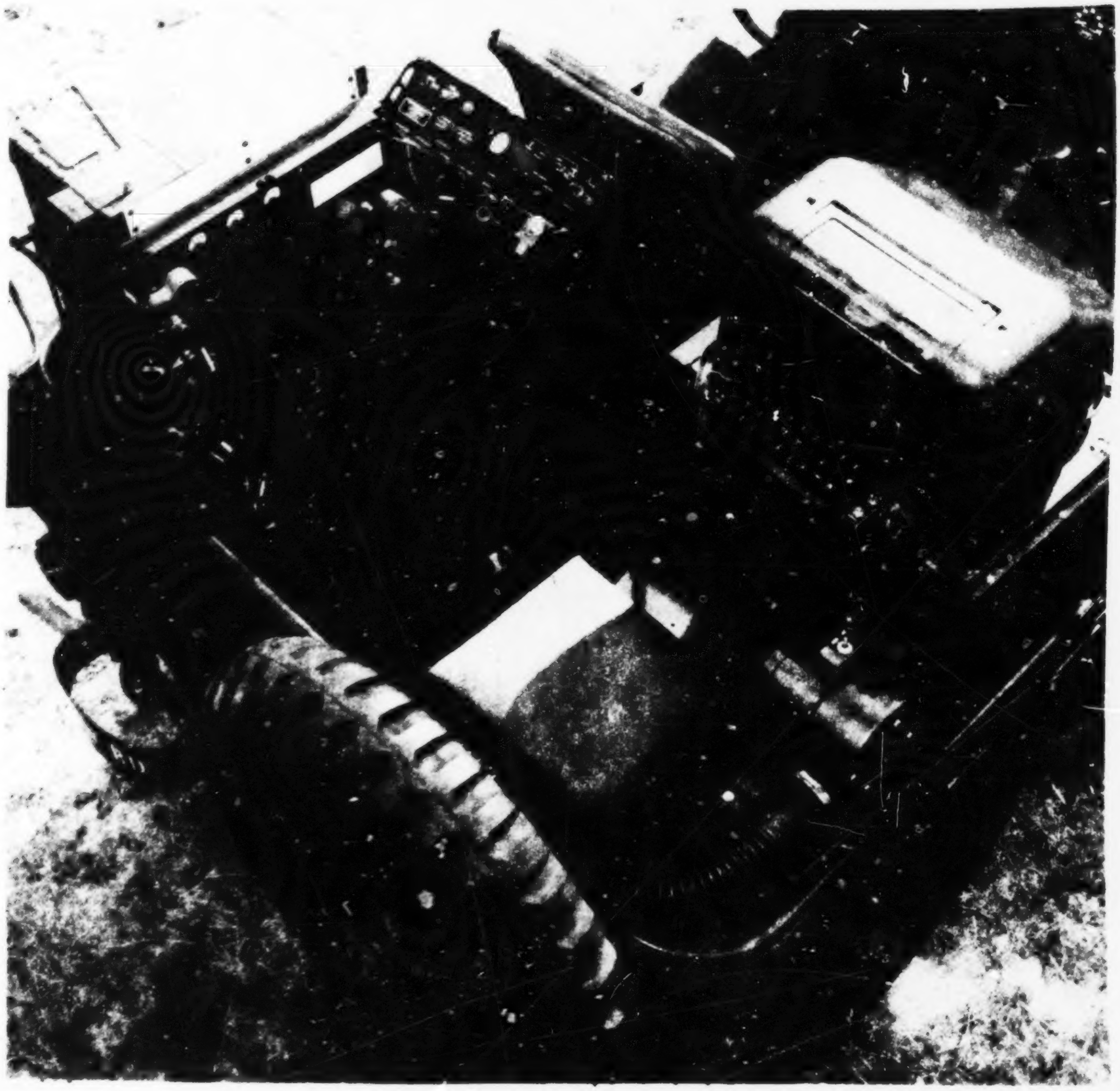

Figure 9-15. Radio teletypewriter set AN/VSC-2.

9-7. AN/PRC-70 Radio

The AN/PRC-70 Radio is capable of SSB, CW, AM, and FM communications. It is man portable.

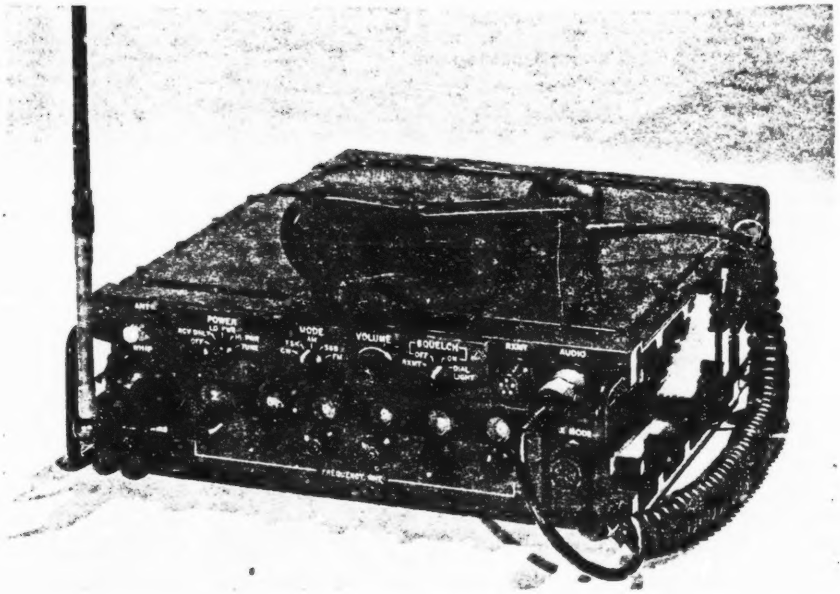
ANT
POWER
MODE
VOLUME
SQUELCH
RXMT
AUDIO

Figure 9-16. AN/PRC-70

CHAPTER 10

WIRE COMMUNICATIONS

Section I. WIRE EQUIPMENT

10-1. GENERAL

Wire is one of the most dependable means of communications. Wire communication includes the use of field wire, wire-laying and-recovery equipment, battery-operated and sound-powered telephones, switchboards, teletypewriters, multiplexers, and other associated or terminating equipment. The decision to establish wire communication depends on the need for it, the time available to install and use it, and the capability to maintain it. The supply of wire on hand, the expected resupply, and future needs must also be considered. Wire is particularly adaptable to static situations but can be used in any tactical operation if its use is properly planned. Wire can be laid from reels mounted in vehicles, reels mounted on axles and carried by hand, reels or dispensers carried by hand, dispensers mounted on aircraft or vehicles, and dispensers carried by rockets or similar projectiles. The installation and operation of a wire or radio system depend to a great extent on the knowledge and training of all personnel. It is important that all officers and men be able to recognize the items of wire equipment in the unit and know the capabilities of the equipment.

a. Advantages of wire communication.

(1) Wire communication affords person-to-person conversation with break-in operation. Break-in operation refers to the capability of the persons conversing to interrupt one another without waiting until a transmission has been completed.

(2) Wire is a more secure means of communication than radio. However, it does not insure complete security of information transmitted in the clear because it is susceptible to enemy monitoring devices.

b. Disadvantages of wire communications.

(1) The time required for installing a wire system is relatively long. However, this time may be reduced by the use of trained personnel and by efficient planning of the system before installation.

(2) The wire communication system is vulnerable to interruption caused, primarily, by breakage of wire lines. Care should be taken in selecting installation sites and routes to prevent broken line.

10-2. FIELD WIRE WD-1/TT.

Field wire WD-1/TT is used for signal communication and is characterized by flexible conductors, high tensile strength, good conductivity, and weatherproof insulation. Field wire WD-1/TT (fig 10-1) is presently used by the combat arms.

It weighs 48 poinds per 1.6 kilometers (mile) and has a tensile strength of 200 pounds (both conductors). Each conductor has three steel strands and four copper strands. The insulation is extruded polyethylene covered with a layer of nylon. The communication range varies with terminal equipment used and other factors, such as weather, method of installation, condition of wire, and number of splices. Table 10-1 indicates the approximate range of the wire when used with telephones organic to the combat arms.

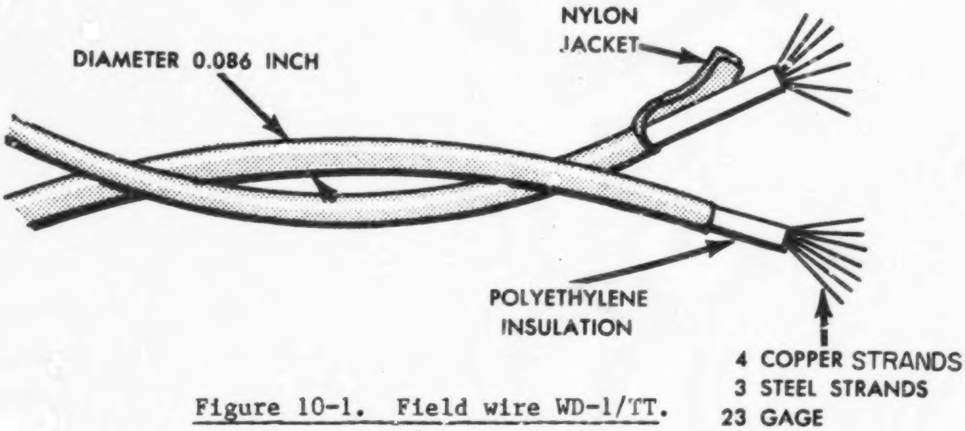

Figure 10-1. Field wire WD-1/TT.

Table 10-1. Approximate Range of Field Wire WD-I/TT

Telephone set	Wet conditions		Dry conditions	
	miles	kilometers	miles	kilometers
TA-1/PT	4	6.4	10	16
TA-312/PT	14	2.24	22	35.4
TA-264/PT				
with amplifier	33	53	61	96.5
without amplifier	12	19.3	18	29

10-3. WIRE SPLICING KIT MK-356/G AND TOOL EQUIPMENT TE-33

The wire splicing kit MK-356/G (fig 10-2) consists of a canvas carrying case, four magazines for splicing connectors (sleeves), and a mechanical crimping cable splicing tool TL-582. A wire cutter and stripper is built into the handle of tool TL-582. The stripped ends of the conductors to be spliced are inserted into opposite ends of the splicing connector in the jaws of the tool. Closing the jaws crimps a connector on the line, thereby making and insulating the splice. A ratchet prevents the jaws from opening until enough pressure is applied to the handle to insure a strong splice. The splice connector is made up of three concentric sleeves: a copper outer sleeve, a plasic intermediate insulator, and a copper insert. This provides a good waterproof electrical connection without the use of tape. Tool equipment TE-33 (fig 10-3) consists of pouch CS-34, pliers TL-13-A, and knife TL-29.

10-4. WIRE PIKE MC-123

Wire pike MC-123 consists of a two-section pole joined by metal fittings. The top section terminates in a hook, fitted with a roller, which is used by a wireman in laying or recovering telephone wire from a truck. As the wire is laid, the hook guides the wire along the side of the road. For wire recovery, the hook provides an even feed and guides the wire to the reeling machine.

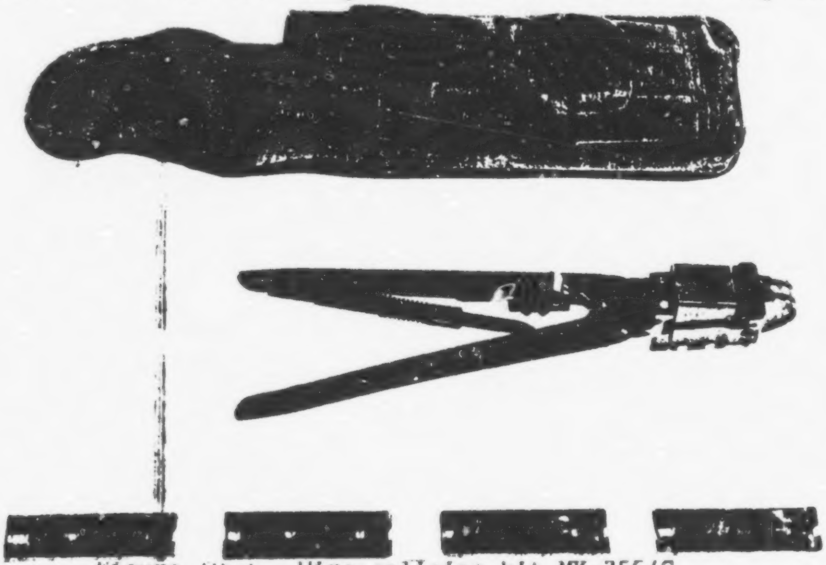

Figure 10-2. Wire splicing kit MK-356/G.

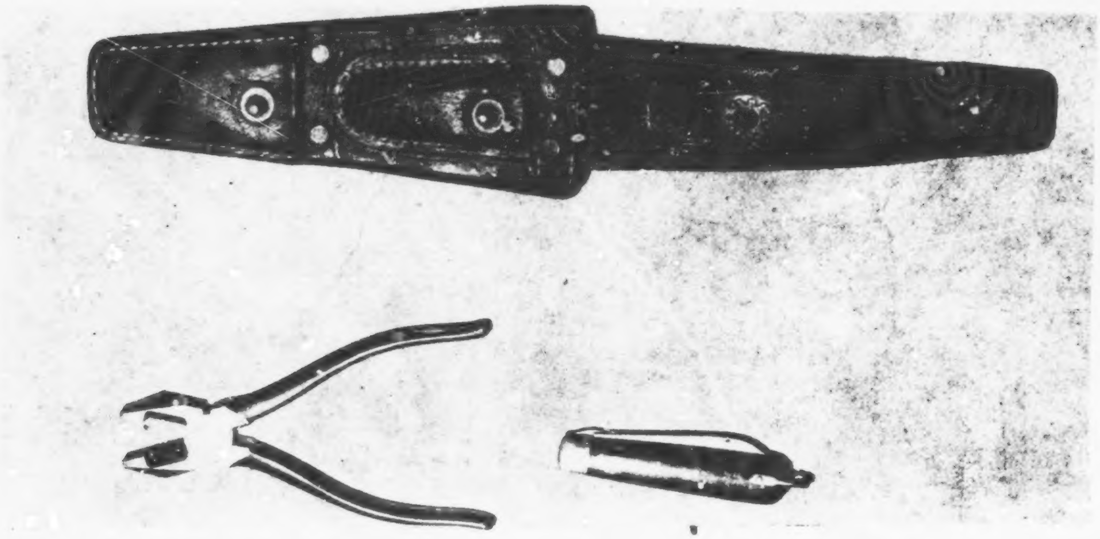

Figure 10-3. Tool equipment TE-33.

10-5. CLIMBERS LC-240/U

a. General. Climbers LC-240/U (fig 10-4) are adjustable, lightweight metal climbers. The length of the climbers can be adjusted from 14 3/4 inches to 19 1/2 inches to conform to different leg sizes. Climbers LC-240/U consist of two leg irons, 2-inch and 3-inch interchangeable gaffs, leather fastening straps, and climber pads. The 2-inch gaffs are used for climbing poles or trees with thin bark, and the 3-inch gaffs are used for climbing trees with thick bark.

b. Adjustment. To adjust the leg irons, remove the two leg iron screws, move the slide assembly on the leg iron to the desired length, and insert and secure the leg iron screws in the nearest screw holes.

c. Gaff removal. To remove a gaff, release the two gaff retaining screws, move the gaff downward toward the stirrup, and lift the gaff out of the retaining slot. Reverse the procedure to replace the gaffs.

d. Gaff sharpening. At present, no gage is available to check the gaffs of climbers LC-240/U. A new gaff may be used as a guide to sharpen dull gaffs. (Gaffs should be sharpened only when replacement gaffs are not available.)

10-6. LINEMAN'S BELT LC-23-( )

Lineman's belt LC-23-( ) consists of a leather body belt and an adjustable leather safety strap. The body belt is supplied in various sizes, according to the distance in inches between the D-rings. Safety straps are furnished in 61-, 68-, and 70-inch lengths. (Fig 10-4)

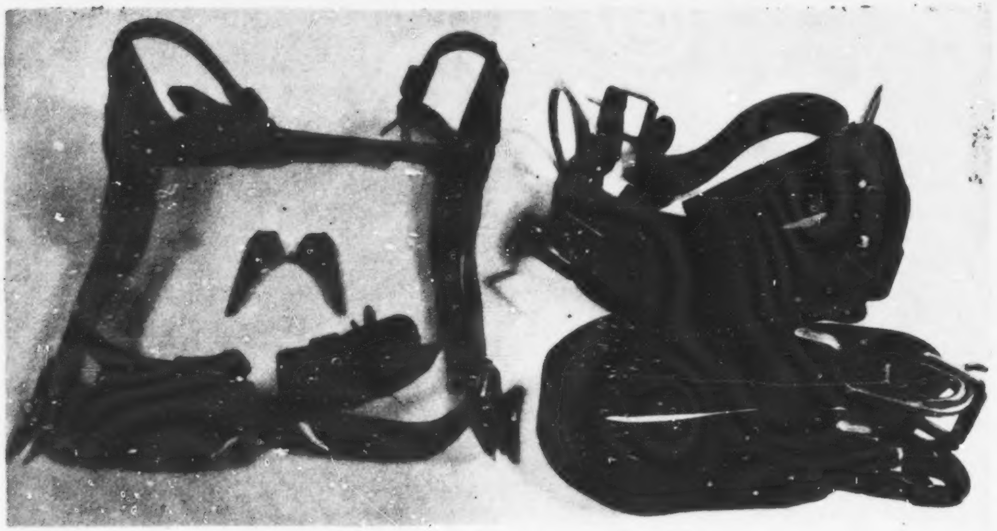

Figure 10-4. Climbing equipment.

10-7. REEL UNIT RL-39.

Reel unit RL-39 (fig 10-5 and 10-6) is used with cable reel DR-8, which holds 400 meters (one-fourth mile) of field wire WD-1/TT. The RL-39 consists of a--

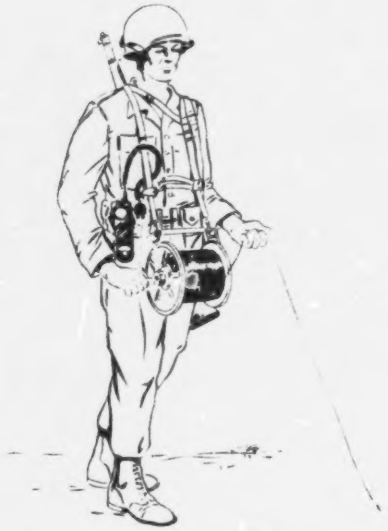

Figure 10-5. Recovering wire with reel equipment CE-11 (RL-39 reel unit with a TA-1 telephone.

a. crank and axle.

b. frame.

c. strap ST-35 (fig 10-6) to support the RL-39 from the neck.

d. strap ST-34 (fig 10-6) to fasten around the waist to secure the RL-39.

10-8. REEL UNIT RL-31E

Reel unit RL-31-E (fig 10-7) is a rugged, lightweight, portable unit designed to facilitate laying and recovering telephone cable. The reel unit (less cable) weighs about 46 pounds. It can be mounted in a vehicle or hand-carried. The frame can be adjusted to the form of an A-frame, a stretcher, or a wheelbarrow. The RL-31-E consists of--

a. Two brake units for controlling the speed of telephone cable payout.

b. Two cranks for turning the axle to recover telephone cable.

c. Two carrying straps for carrying the reel unit litter style.

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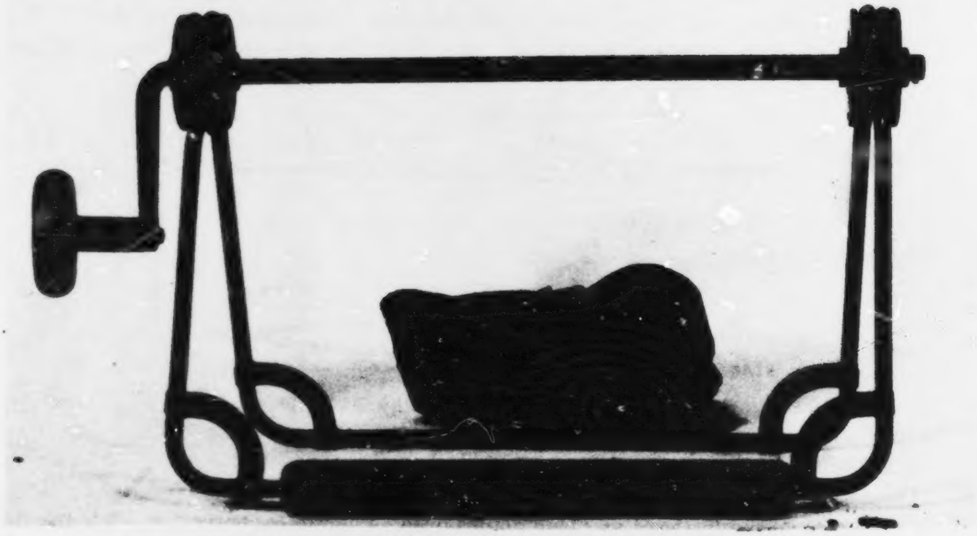


Figure 10-6. Reel unit RL-39.

d. A divided axle, which holds the reels on the frame. The axle allows the use of two reels, either of which can be operated independently of the other.

e. A frame, which provides a bracket for holding the split axle.

10-9. AXLE, RL-27-B

Axle, RL-27-B (fig 10-8) is an 8 pound, 2 1/2 foot-long machined steel bar with two knurled handles. One handle can be removed to permit placing the reel on the axle. The other handle is designed to receive the crank. The RL-27-B is used for laying and recovering short wire circuits by hand. The RL-27-B consists of--

a. An axle with a removable handle for mounting the cable reel.

b. A crank for turning the axle to recover the cable on the reel.

10-10. REELING MACHINE, CABLE, MOTOR-DRIVEN, RL-172/G

Reeling machine, cable, motor-driven, RL-172/G (fig 10-9) is a transportable wire-laying and wire-recovering machine that can be mounted on a motor vehicle. The reeling machine normally is mounted vertically on the tailgate of a truck. It also may be operated horizontally from the bed of a truck.

a. The reel is driven by a 24-volt DC motor. Power for the motor is provided by the vehicle battery.

b. A handcrank is provided for manual operation.

c. The reeling machine is designed for one-man and is provided with controls for starting, stopping, and reversing the direction of rotation of the reels.

Notes.

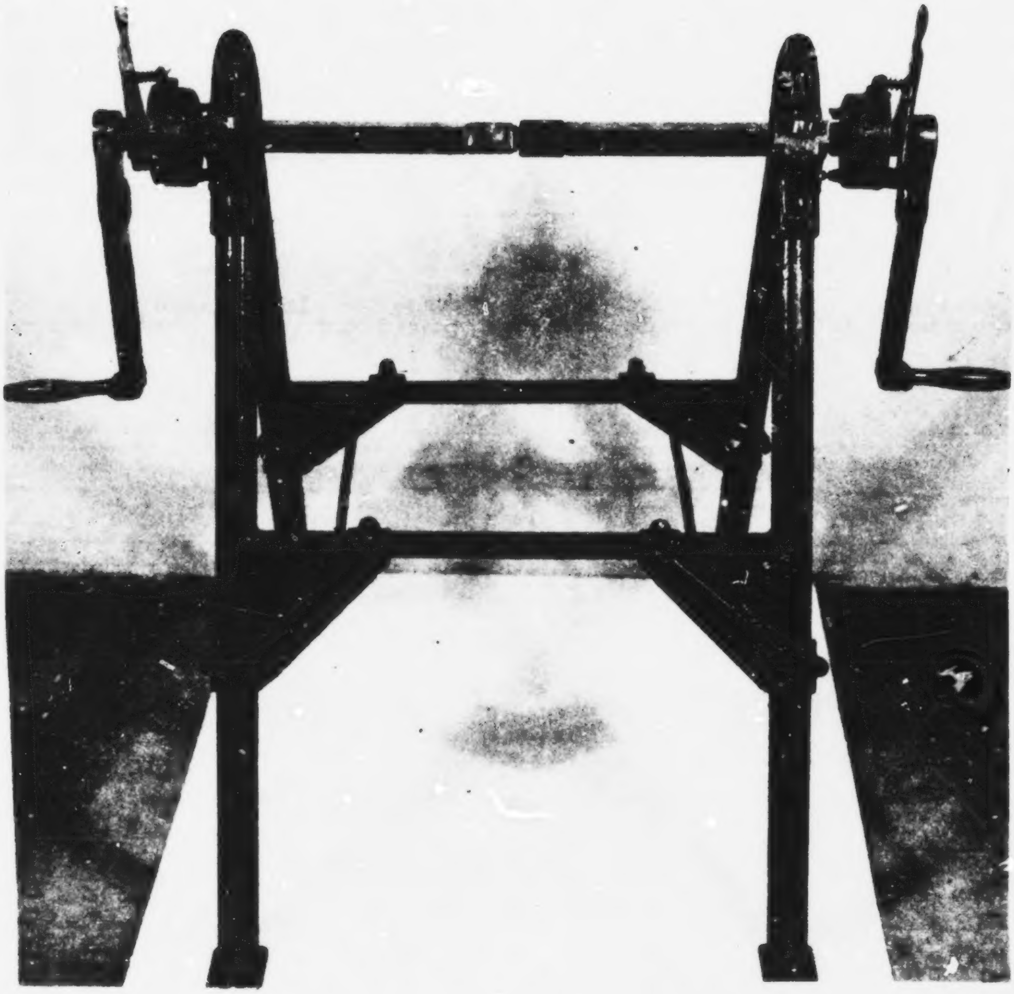


Figure 10-7. Reel unit RL-31-E.

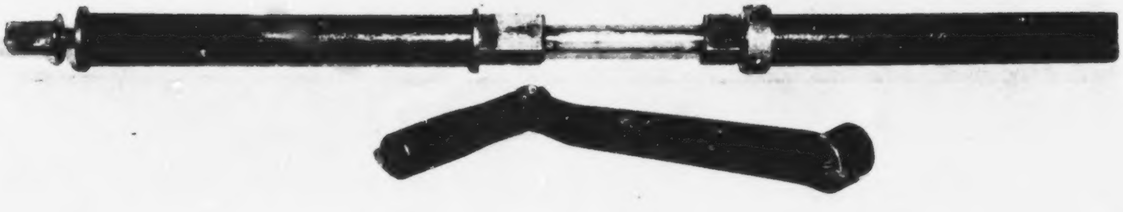


Figure 10-8. Axle, RL-27-B.

d. The wire can be payed out or reeled in from either the back or the front of the reel. The speed of the reel can be varied from 0 to 300 revolutions per minute (rpm); the wireman controls the speed by using the braking mechanism and varying the pressure on the control hanle.

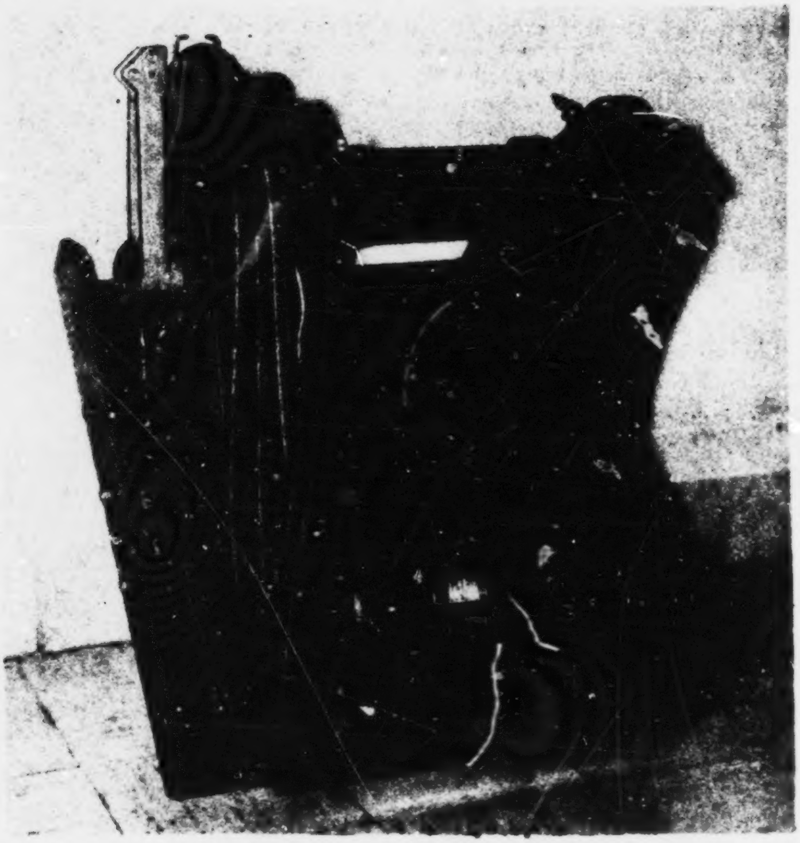


Figure 10-9. Reeling machine, cable, motor-driven, RL-172/G.

10-11. REELING MACHINE, CABLE, ENGINE-DRIVEN, RL-207/G

a. General. The RL-207/G (fig 10-10) is a two-cylinder, gasoline-engine-driven reel unit mounted in a 5/4-ton truck or larger vehicle; it is used for paying out or recovering field wire WD-1/TT or spiral-four cable. It will accomodate two RL-159/U's, one DR-5, or one DR-15 per axle. The upper or lower axle can be used individually, or the two axles can be used simultaniously.

b. Characteristics.

(1) Operation: Power-driven or manual.

(2) Speeds:

(a) WD-1/TT payout: 25 mph (max).

(b) Spiral-four cable payout: 10 mph (max).

(c) WD-1/TT or spiral-four recovery: 5 mph (max).

(3) Fuel capacity: 1 1/2 gallons.

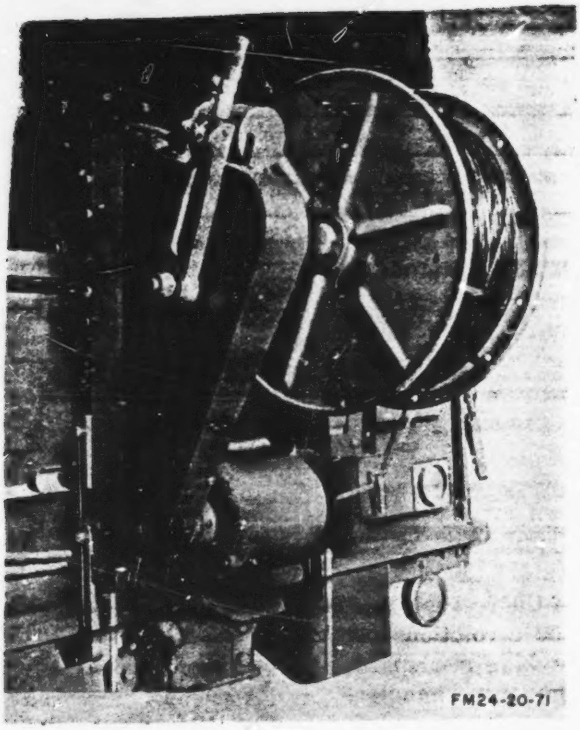


Figure 10-10. Reeling machine, cable, engine-driven, RL-207/G.

(4) Reels:

(a) DR-5: Two (one per axle).

(b) DR-15-B: Two (one per axle).

(c) RL-159/U: Four (two per axle).

(5) Weight: Approximately 490 pounds without reels.

WARNING: Follow operating instrucions carefully. When operating the equipment, always stand beside the equipment; never stand in line with the cable reels when they are turning. Check to be sure that all hub lock levers are in the horizontal position and that the reels are installed so that they unwind from the top of the reel.

10-12. REELS, CABLE, RL-159/U (fig 10-11) is a metal drum that holds 1.6 kimometers (1 mile) of field wire WD-1/TT. It is used with reeling machines RL-27-B, RL-31-E, RL-172/G, and RL-207/G.

b. Reel, cable, DR-8 (fig 10-11) is a metal drum used to hold 400 meters (one-fourth mile) of field wire WD-1/TT. It is used with reeling machine RL-39.

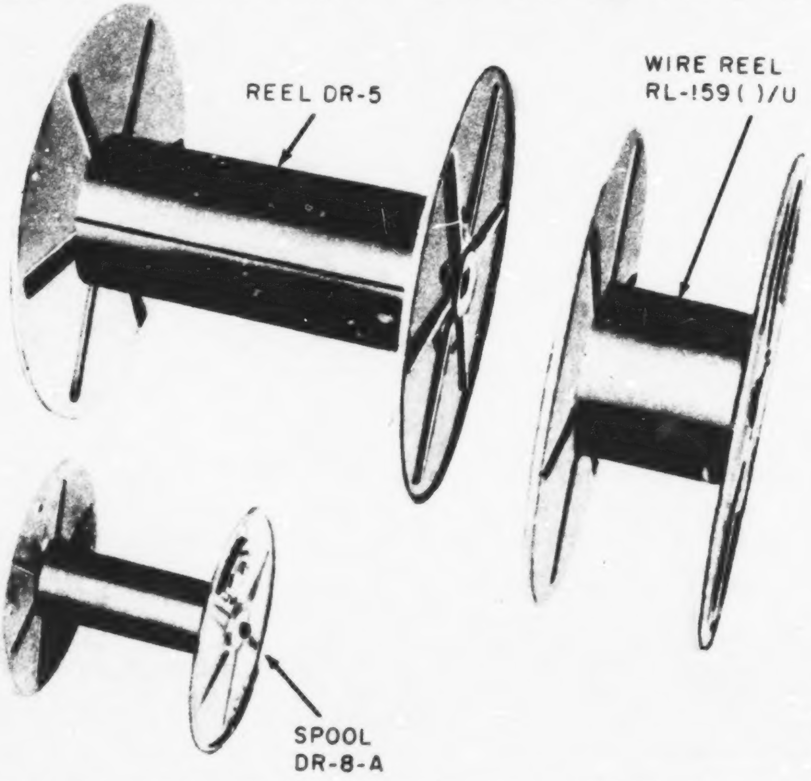


Figure 10-11. Reels, cable, RL-159/U, DR-5, and DR-8.

c. Reel, cable, DR-5 (fig 10-11) is a metal drum used to hold 4 kilometers (2 1/2 miles) of field wire WD-1/TT. It is used with reeling machines RL-31-E and RL-207/G.

10-13. WIRE DISPENSER MX-306A/G

Wire dispenser MX-306A/G (fig 10-12) is an expendable dispenser suitable for laying field wire WD-1/TT from a packboard or from Army aircraft. The coil-wound cable can be laid from a hand-carried or vehicle-mounted dispenser. Wire dispenser MX-306A/G, with 800 meters (one half-mile) of field wire WD-/TT, is 14 inches in diameter and has a 4-inch hole through the center. It can be used instead of the RL-39 if the weight of the additional wire will not interfere with operations. The 3.5-inch rocket launcher can be used for laying telephone cable from wire dispenser MX-306A/G. In emergencies, a rifle grenade can also be used.

WARNING: Keep personnel away from the wire being payed out. Use dummy rocket launcher ammunition and dummy rifle grenades.

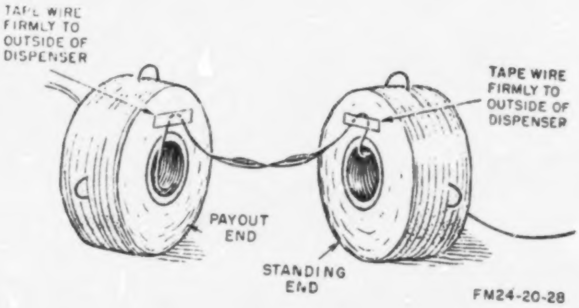

TAPE WIRE FIRMLY TO OUTSIDE OF DISPENSER
TAPE WIRE FIRMLY TO OUTSIDE OF DISPENSER
PAYOUT END
STANDING END
FM24-20-28

Figure 10-12. Wire dispenser MX-306A/G.

Section II. FIELD TELEPHONES

10-14. GENERAL

Field telephone sets are portable, self-contained units designed for use in the field. Specific field telephones are selected according to the type of service available. Service may be over switched circuits or over point-to-point circuits.

10-15. TELEPHONES SET TA-312/PT

Telephones set TA-312/PT (fig 10-13) is a rugged, lightweight, waterproof field telephone set; it may be employed in a local-batttery-signaling (CBS), or common-battery (CB) system. The telephone set weighs approximately 9 1/2 pounds. The transmission range of telephone set TA-312/PT, employed with field wire WD-1/TT, is from 22 to 35 kilometers (14 to 22 miles), depending on the condition of the cable.

The telephone set was designed for use with either the telephone handset or an auxiliary headset microphone. Operation with the headset microphone is particularly desirable in units in which personnel, such as computers and recorders, must have both hands free to operate other equipment. This telephone may be used as a sound powered transmitter by taking through the receiver element. The planning range for this type of operation is approximately 6 kilometers.

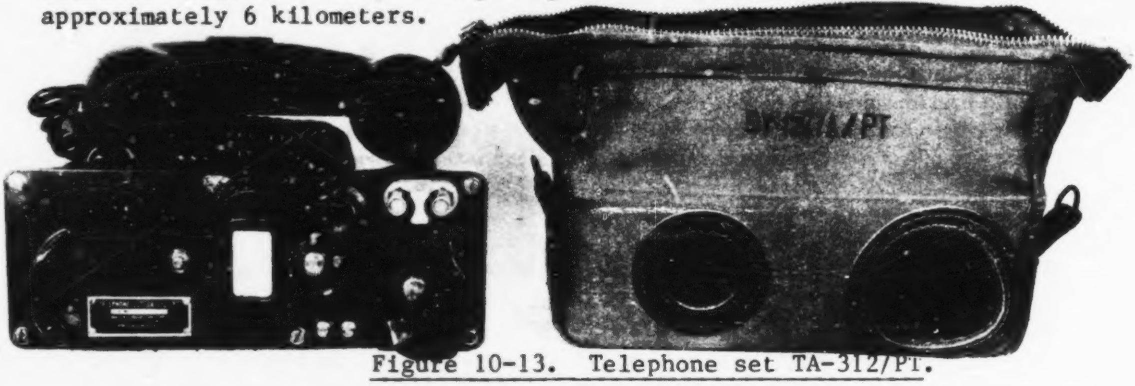


Figure 10-13. Telephone set TA-312/PT.

a. Preinstalation checks. Before the telephone set is installed, it should be checked for proper operation. The following tests require no special test equipment and may serve to identify a defective component:

(1) Local-battery operation.

(a) Loosen the carrying case retaining strap over the battery compartment, turn the battery compartment latch clockwise, and open the cover.

(b) Insert one battery BA-30 with its center terminal down and another battery BA-30 with its center terminal up. Close and latch the battery compartment cover and replace the carrying case retaining strap.

(c) Turn the circuit selector switch to the LB position. Depress the handset press-to-talk switch. Speaking into the transmitter should produce a side-tone. Release the press-to-talk switch to eliminate the sidetone. Turn the generator crank while operating and releasing the press-to-talk switch. Additional torque is required to turn the generator crank when the press-to-talk switch is depressed. These steps will electrically test the batteries, the transmitter and receiver elements, all contacts of the press-to-talk switch, all contacts of the line switch and generator switch, and the continuity of the entire LB circuit. If the telephone does not test properly, it should be turned in for repair.

(2) Common-battery-signaling operation.

(a) Turn the circuit selector switch to the CBS position.

(b) Repeat the tests described for the LB circuit. Operating the press-to-talk switch should not affect the operation of the generator, but depressing the line switch should reduce the torque required to turn the generator. The same circuits are tested in the common-battery-signaling operation tests as those tested in the local-battery operation tests.

(3) Common-battery operation.

(a) Remove the two batteries BA-30 from the battery compartment.

(b) Turn the circuit selector switch to the CB position.

(c) Turn the generator crank. At low speeds, a clicking sound should be heard in the receiver; at higher speeds, blowing across or speaking into the transmitter should produce transmitter sidetone. It is not necessary to operate the press-to-talk switch. Depress the line switch to eliminate the sidetone and reduce the torque required to turn the generator crank. This will electrically test the receiver and transmitter elements, line switch, generator, and holding coil. If the telephone does not test properly, it should be turned in for repair.

(4) Buzzer circuit. With the handset mounted in the retaining brackets, connect the telephone set being tested to another telephone set known to be in operating condition. Turn the generator crank of the good telephone set. The buzzer on the telephone set being tested should operate, and the volume should vary as the volume control knob on the telephone set being tested is rotated clockwise from the LOW position to the LOUD position. The function of the entire buzzer circuit is tested with this check.

(5) Overall set test.

(a) Connect the telephone set being tested to another telephone set known to be in operating condition.

(b) Install two batteries BA-30 in each telephone set.

(c) Turn the selector switch of each telephone to the LB position.

(d) Have an assistant operate the good telephone set and complete a two-way conversation between the two telephone sets. This will test the transmitter and receiver circuits of the telephone set being tested.

(e) Turn the generator crank of the telephone set being tested. The buzzer of the good telephone set should operate. This tests the generator of the telephone set being tested.

(f) Turn the generator crank of the good telephone set. The buzzer of the telephone set being tested should operate. This tests buzzer circuit.

(g) If the telephone set does not test properly, it should be turned in for repair.

b. Installation.

(1) Telephone set TA-312/PT may be installed on a tree or pole. Unfasten the carrying strap from the end farthest from the line terminals, place the telephone set against the support at a convenient height, wrap the carrying strap around the support and secure it to the ring in the case, and insert a piece of field wire through the lower loop on the back of the canvas case and tie it securely around the support.

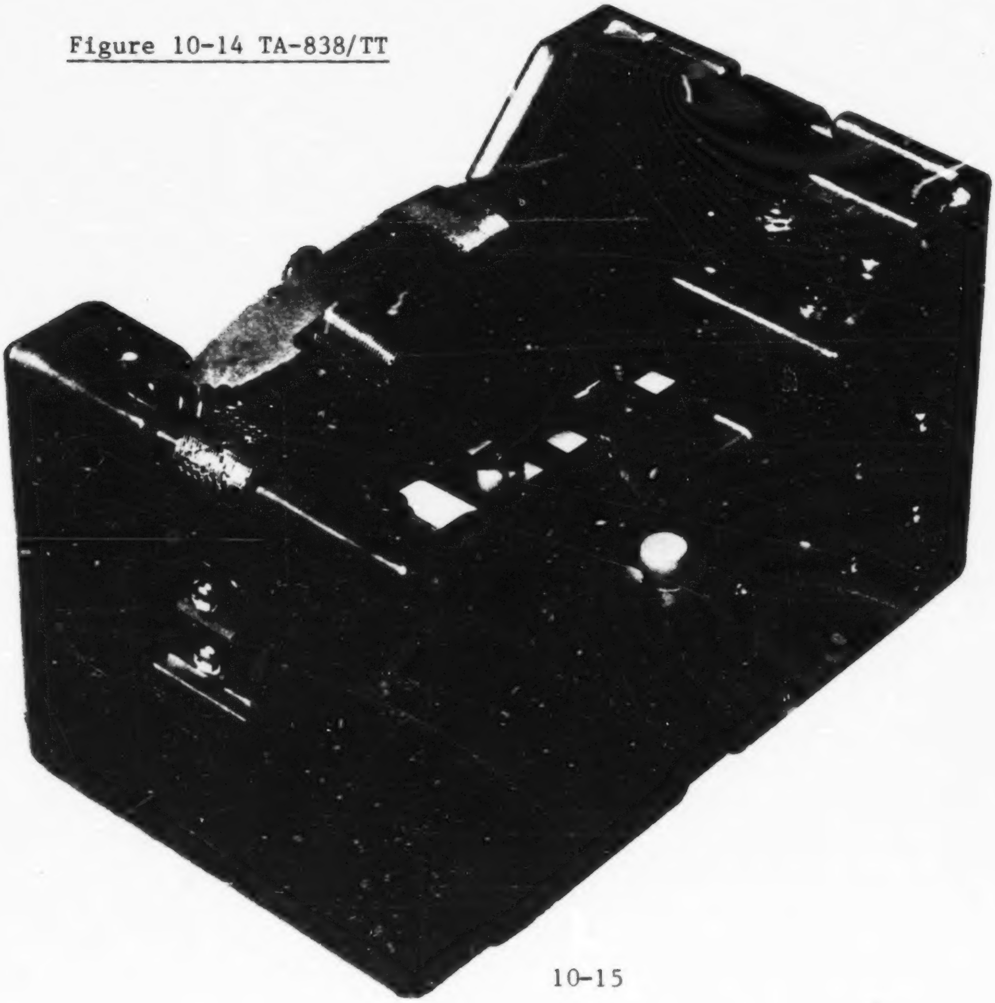
CAUTION: The LINE 1-2 binding posts must be up for proper positioning of the handset in its retaining brackets.

(2) When the telephone set is used as a desk set in a semipermanent installation, the canvas case may be removed and stored for future use.

(3) Remove about 1 inch of insulation from each wire of the pair of line connections (field wire WD-1/TT).

(4) Fold back the skinned portion of each wire about one-half inch.

Figure 10-14 TA-838/TT



(5) Push down on one of the LINE-1-2 binding posts, insert the bare end of one of the wires into the binding post slot, and release the pressure. Be sure that the wire is clamped firmly. Repeat the procedure for the other wire and binding post.

(6) Tie the wire to the D-ring on the carrying case.

(7) Operate the selector switch for the type of operation desired--local-battery, common-battery, or common-battery-signaling. Install two batteries BA-30 in the battery compartment for local-battery or common-battery-signaling operation.

10-16. TELEPHONE SET TA-264/PT

Many times in a field situation it becomes necessary for commanders, staff officers, and other personnel to communicate over ranges that greatly exceed the normal talking range of telephone set TA-312/PT. The ability to communicate over greater ranges is made possible by use of vacuum tube amplifiers in both the transmitting and receiving circuits of telephone TA-264/PT (fig 10-14). Power is supplied by dry batteries installed in the telephone. TA-264/PT is intended primarily for use at the terminals and at intermediate points between terminals of a two-wire line. When used in this way (noise and crosswalk conditions permitting), the telephone obtains approximately double the transmission range obtained with other local-battery sets. The telephone may also be used without the amplifiers as a local-battery set. When amplifiers are used, radiotelephone procedure must be observed, since simultaneous transmission and reception are not possible with the amplifiers in the circuit. In this case, close cooperation between personnel using the equipment is necessary for efficient operation. This equipment contains vacuum tubes and must be handled with the same care as a radio set. Telephone set TA-264/PT is provided with a bell for audible signaling and a visual signal for silent signaling. A switch is provided to select either type of signaling device. The visual signal is designed so that the telephone can be used in darkness. When ringing current is received, the signal leaf flies up and the operator can determine its position by passing his hand over the leaf.

10-17. TELEPHONE SET TA-1/PT.

Telephone set TA-1/PT (fig 10-16) is a completely sound-powered field telephone for use on field wire lines in forward areas. It can be used for communication with other field telephones or local-battery switchboards. The telephone TA-1/PT provides an audible signal and a visual signal. The audible signal can be adjusted in volume from loud to complete silence. The visual signal operates whenever the telephone is signaled, regardless of the position of the volume control lever. The planning for this telephone is 4 miles or 6.4 kilometers.

10-18. GENERAL

Field telephone switchboards are manually operated, constructed to withstand rough handling, and designed for quick, simple installation. Manual telephone switchboards are designed for several types of operation--common-battery, local-battery, and common-battery-signaling operations. Some field switchboards are designed specifically for one type of operation; others are designed for all three types. In common-battery system, the source of electrical energy for speech and ringing signals is located at the switchboard telephone central.In a local-battery system, the source of electrical energy is a component of the telephone set. In the common-battery-signaling system, the source of power for speech is part of the telephone set and the power for signaling the switchboard is located at the switchboard. Switchboards common to the combat arms are discussed in paragraphs 10-19, 10-20, and 10-21.

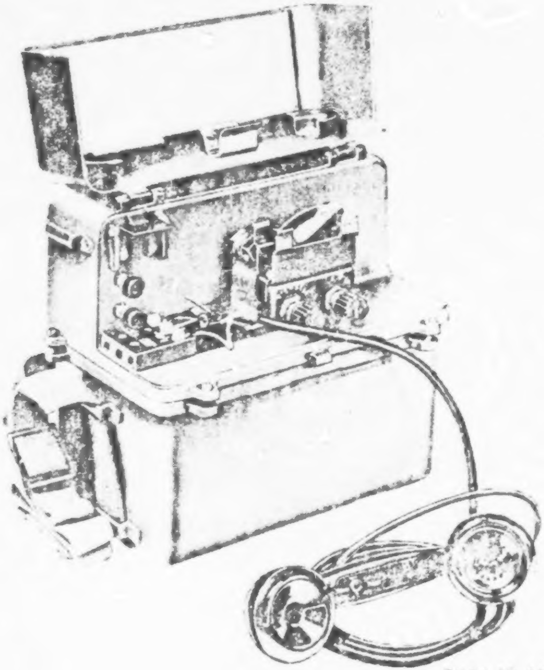


Figure 10-15. Telephone set TA-264/PT.

10-19. MANUAL TELEPHONE SWITCHBOARD SB-993/GT

Manual telephone switchboard SB-993/GT (fig 10-16) weighs 2 1/4 pounds. It will handle one operator's line and six local-battery wire circuits. (This switchboard replaced emergency switchboard SB-18/GT.) Manual telephone switchboard SB-993/GT consists of--

a. A canvas carrying case to protect and carry the switchboard when not in use.

b. An adapter plug holder to hold the adapter plugs in position for operation.

c. Seven adapter plugs, six of which are used to attach the six incoming wire circuits to the switchboard. The seventh adapter plug is connected to a field telephone for the switchboard operator.

d. A 7-foot mounting strap to secure the adapter plug holder to a tree or table for support when in use.

Telephone Set

TA-838/PT

10-20.

General Information

The TA-838/TT is a ruggedized, solid state field telephone designed for use with the SB-3614/TT switchboard or with the AN/TTC-25 or AN/TTC-38 tactical automatic switches. It is a 2- or 4-wire, local or common battery set using dual-tone, multifrequency (DTMF) tones for signaling. Up to four sets can be bridged across a single 4-wire line for extension service.

Technical Characteristics

RANGE	3.2 km (2 mi) from SB-3614/TT under worst conditions
TYPE OF OPERATION	Local or common battery
SIGNALING VOLTAGE	-4 dBm (± 2 dB)
TYPE OF SIGNAL	Audible tone
POWER REQUIREMENT	6V dc (4 ea BA-42 or BA-2042)
WEIGHT	3.6 kg (8 lb)

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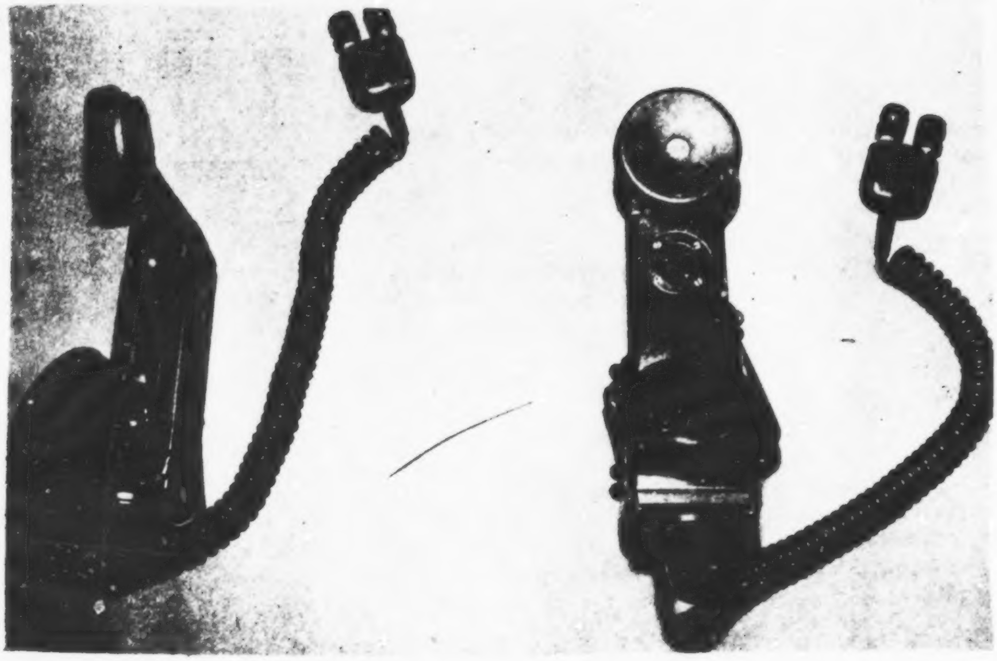

Figure 10-16. Telephone set TA-1/PT.

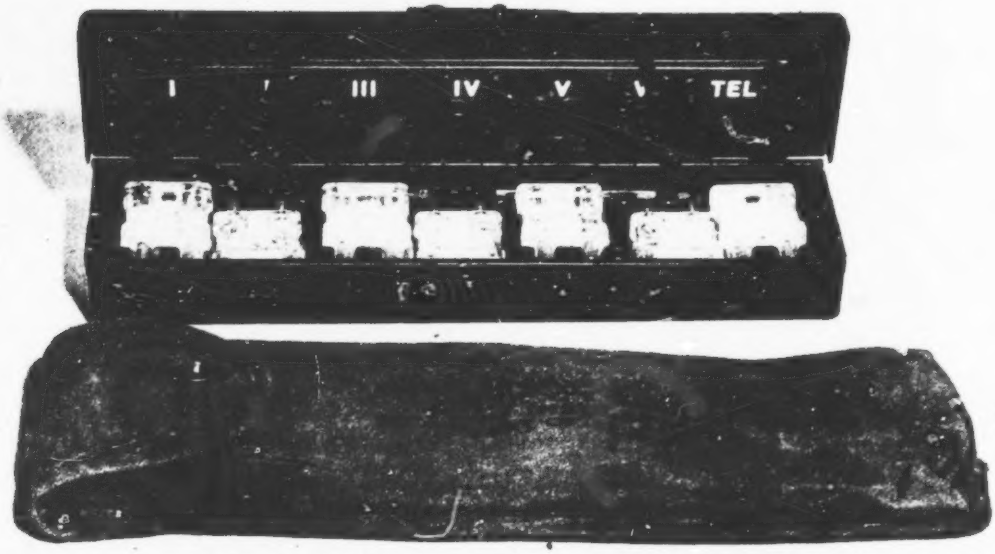
I
III
IV
V
TEL

Figure 10-17. Manual telephone switchboard SB-993/GT.

10-21. MANUAL TELEPHONE SWITCHBOARD SB 22/PT

Manual telephone switchboard SB-22/PT (fig 10-17) weighs 30 pounds. It is a 12-line, retractable monocord, local-battery switchboard designed to withstand the vibration and shock normally encountered under field conditions. Local or trunk and operator's circuits are contained in units that may be quickly replaced in the event of failure. When two switchboards are stacked, one operator's pack may be replaced by five line packs to provide 17 circuits in the second board, or a total of 29 circuits for two stacked switchboards (fig 10-18). Facilities are provided for answering, ringing, and supervising on each line. Means are also provided for selection of an audible alarm or a visual alarm in the operator's pack, in addition to the visual indicator on each line pack.

a. Components.

(1) Bare unit and cover. The bare unit contains the line packs, operator's pack, headset microphone H-144/U, and battery case. It also contains a terminal strip in the rear for connecting incoming circuits.

(2) Operator's pack. The operator's pack provides a talking and listening circuit, a housing for the hand generator, an operator's cord, and necessary switches for operation at the switchboard.

(3) Fifteen line packs. Twelve line packs are used to interconnect the line circuits terminating at the switchboard, and three serve as spares in accessory kit MX-230A/PT.

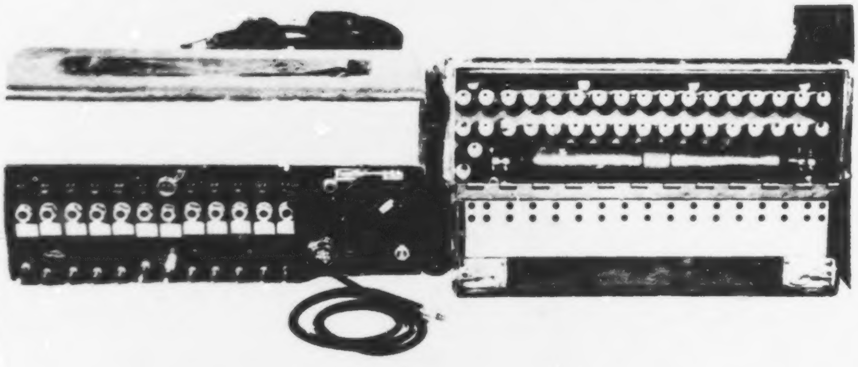

Figure 10-18. Manual telephone switchboard SB-22/PT.

(4) Accessory kit MX-230A/PT. Accessory kit MX-230A/PT contains three line packs and two lamps.

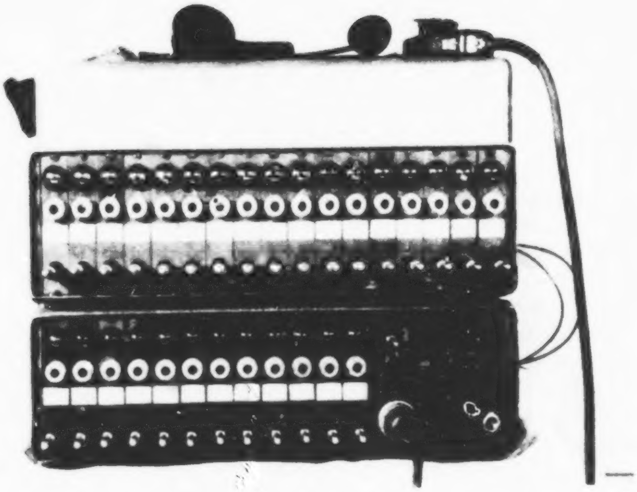

Figure 10-19. Two SB-22/PT's stacked for series operation (front view).

(5) Headset microphone H-144/U (H-182/U). The headset microphone is used by the switchboard operator and is connected to the front of the operator's pack.

Note. Accessory kit MX-2915/PT is provided with the SB-22A/PT. The MX230A/PT and MX-2915/PT are identical except that the MX-2915/PT contains two line packs and one trunk pack.

b. Installation.

(1) Since the SB-22/PT has no legs for support, place it on the ground or on some other support.

(2) Ground the board to a suitable ground stake.

(3) Connect the wire lines to the terminal strip and record the circuit identification on the identification strip of the associated line pack.

(4) Install the batteries in the battery case and see that the case is properly connected to the terminal strip.

(5) Remove the headset microphone from the front cover of the switchboard and connect it to the proper receptable on the operator's pack.

(6) Connect the external source of ringing current, if available, to the terminal strip.

c. Testing the line packs.

(1) Connect a telephone to the line terminals associated with the line pack at the extreme left side of the front panel.

(2) Operate the hand ringing generator of the telephone. The drop should operate.

(3) Insert a plug into the jack of the line pack under test. The drop should restore.

(4) Extend the cord of the line pack under test a distance of approximately 1 foot and release it. It should retract completely into the line pack.

(5) Repeat the steps in (1) through (4) above for each line pack.

d. Testing the operator's pack.

(1) Connect a telephone to any line pack that has been properly tested.

(2) Insert the plug of the operator's pack into the jack of the line pack.

(3) Hold and RING BACK-PWR RING FWD switch in the RING BACK position and rotate the crank of the switchboard generator. The ringer of the test telephone should operate.

(4) Remove the plug of the operator's pack from the line pack. Place the ALARM switch in the VIS position. Operate the generator of the test telephone. The lamp should light.

(5) Place the ALARM switch in the AUD position. Operate the generator of the test telephone. The alarm buzzer should sound.

(6) Connect the headset microphone to the operator's pack. Plug the cord of the operator's pack into the jack of the line pack connected to the test telephone. Two-way conversation should be possible.

10-22. MANUAL TELEPHONE SWITCHBOARD SB-86/P

Manual telephone switchboard SB-86/P (fig 10-19) is a portable, 30-line, retractable cord field switchboard. It weighs 180 pounds (less batteries). It will operate in either a common-battery-signaling or local-battery system and provides conference facilities. In addition, two line are modified for use as trunklines between this switchboard and any commercial, common-battery, or manual switchboard or central office set. Manual telephone switchboard SB-22/PT is used in conjunction with this switchboard to provide radio/wire integration facilities. When transported, the switchboard is placed in a waterproof case.

a. Components.

(1) Outer cover assembly. The outer cover assembly is a metal case that serves as a storage and carrying case for the switchboard.

(2) Manual telephone switchboard SB-248/P. The SB-248/P is a metal case containing eight cord telephone circuits TA-208/P (cord pack) and one operator's telephone circuit TA-220/P (operator's pack). The common name for the SB-248/P is the keyshelf section.

(3) Switchboard signal assembly TA-207/P. The TA-207/P is a metal case containing 30 line circuits. Handset microphone H-91/U is used as the operator's telephone set. The common name for the TA-207/P is the jack field section.

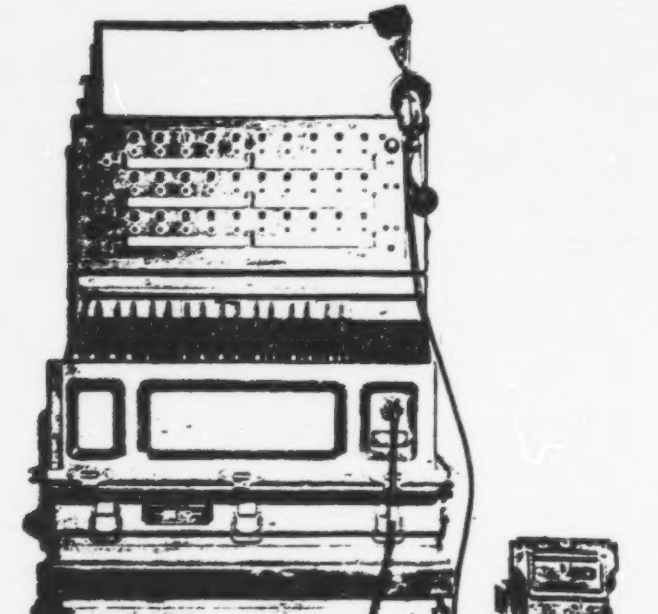

Figure 10-20. Switchboard, telephone, manual SB-86/P.

(4) Power supply PP-990/G. The PP-990/G is a metal case containing switches, a voltmeter, binding posts, and compartments for two banks of batteries.

(5) Power cords. The set has one two-wire power cord and one three-wire power cord.

(6) Spare parts. Spare parts are carried in a canvas roll and stored in the rear compartment of switchboard signal assembly TA-207/P.

b. Technical characteristics.

(1) Line capacity: 30 circuits when one jack field section is used; 60 circuits when two jack field sections are used.

(2) Telephone cord circuits: 16.

(3) Power requirements:

(a) Common-battery signaling and line and supervisory operation: 20 to 26.5 volts DC (five dry cells in powerpack).

(b) Magneto signaling: 15 to 26.5 volts DC (five dry cells in powerpack).

(c) Operator's telephone: 3 volts DC (two dry cells in operator's pack).

(d) Night alarm and panel: 3 volts DC (two dry cells in jack field section).

(4) Ringing facilities:

(a) Automatic: 20-hetz vibrator in powerpack.

(b) Manual: Hand generator in operator's pack.

(5) Operating distance over field wire WD-1/TT:

Type of signaling	Distance	
	miles	kilometers
Magneto signaling	22	35.4
Common-battery-signaling line	4.5	7
Common-battery-signaling trunk	9	14
Common-battery-signaling trunk to civilian switchboard	4.5	7

c. Installation.

(1) Select an area that is relatively smooth for the switchboard.

(2) Release the 12 trunk-type latches and place the cover on the ground, open side down.

(3) Unlock the switchboard legs by releasing the cam lever and rotating the retaining plate until the legs are released. Open the legs by swinging them outward until they lock into position. Place the cover on the ground, open end up, and remove the powerpack.

(4) Place the keyshelf section on the open end of the cover (switchboard base) in either of two positions:

(a) Place the keyshelf section on the switchboard base so that the front and rear of the keyshelf section are flush with the edge of the base.

(b) Place the keyshelf section on the switchboard base so that the front of the keyshelf section extends approximately 4 inches forward of the base. This position provides no leg room for the operator.

(5) Place the jack field section in the space provided on the top of the keyshelf section and secure it with the latches. A second jack field section may be installed by stacking it on top of the first one. The second jack field section will provide an additional 30 lines.

(6) Install the log plate on top of the jack field section.

(7) Open the rear door of the jack field section and keyshelf section by unlocking the cam locks with a screwdriver.

(8) Remove the operator's handset from the canvas bag located on the door of the keyshelf section and connect it to the 10-pin audio connector on the front of the keyshelf section.

d. Installation of batteries in power supply PP-990/G. Batteries BA-200/U are installed in two banks, an upper bank and a lower bank. The upper bank provides current for the operation of the line and supervisory signals; the lower bank provides current for the operation of the vibrator.

(1) Remove the power supply chassis from the case by opening the four latch fasteners on the power pack. The battery compartments are located on both sides of the power supply chassis.

(2) Install each battery BA-200/U by turning the door holders one-fourth of a turn so that they release the lockplate. Swing the lockplate out. The door assembly will open so that the battery can be installed.

(3) Place the battery in the compartment with the terminal end toward the rear of the compartment.

(4) Close the door by reversing the procedure described in (2) above.

e. Installation of batteries in the jack field section TA-207/P. Install two batteries BA-30 in the upper battery compartment of the jack field section to supply 3 volts DC for operation of the night alarm and panel lamps.

f. Installation of batteries BA-30 in the battery compartment. Install two batteries BA-30 in the battery compartment of the operator's pack to supply 3 volts DC for the operator's talking circuit.

g. Connecting.

(1) Grounding

(a) Connect a wire from the EARTH GND binding post on the jack field section to the upper EARTH GND binding post on the operator's pack.

(b) Connect a wire from the lower EARTH GND binding post on the operator's pack to a ground rod.

(2) Battery and ringing power connections. To provide battery and ringing power to the SB-86/P (fig 10-20) from power supply PP-990/G--

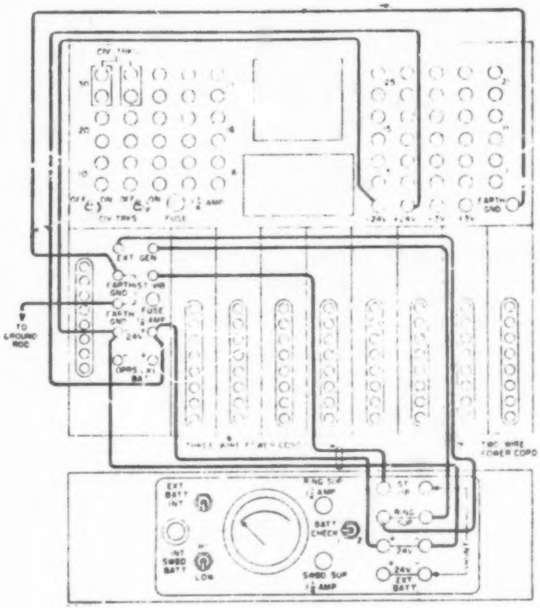
CIV TRK
30
20
10
OFF ON OFF ON
1/4 AMP
CIV TRKS
FUSE
25
15
-24V
+24V
-3V
+3V
EARTH GND
EXT GEN
EARTH GND
VIB
EARTH GND
FUSE 1/4 AMP
24V
OPRS EXT BAT
TO GROUND ROD
THREE WIRE POWER CORD
TWO WIRE POWER CORD
EXT BATT INT
INT SWBD BATT
LOW
RING SUP 1/4 AMP
BATT CHECK
SWBD SUP 1/4 AMP
RING SUP
24V
24V EXT BATT

Figure 10-21. Wire hookup of switchboard SB-86/P for normal field operation.

(a) Connect two wires from the -24V and +24V binding posts on the jack field section to the corresponding binding posts on the operator's pack.

(b) Connect the three-conductor, rubber-covered cable from the powerpack to the operator's pack by connecting the white lead to the -24V binding posts, the black lead to the +24V binding posts and the red lead to the ST VIB binding posts.

(c) Connect the two-conductor rubber-covered cable from the RING SUP binding posts on the power pack to the EXT GEN binding posts on the operator's pack.

(3) Connecting the battery to the SB-86/P (without power supply PP-990/G). Install one battery BA-2 in the lower battery compartment in the rear of the jack field section. This battery furnishes 22.5 volts DC to the line and supervisory signals in the event power supply PP-990/G is not available. Connect the battery leads to the -24V and +24V binding posts.

h. Controls and functions.

(1) Jack field section, keyshelf section and power pack:

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10-23.

Communications Patching Center

AN/TSC-76

General Information

The AN/TSC-76 is air- or vehicular-transportable communications patching center used to provide an audio technical control facility for use in a division communications system. The AN/TSC-76 provides facilities for patching, testing, and monitoring telephone circuits and voice-frequency teletypewriter circuits. It can handle 572 two-wire circuits. It is used at division level in an area communications system.

MAJOR COMPONENTS-------------- 1 Electrical Equipment Shelter
S-403/TSC-76 (modified S-250/G)
1 Manual Telephone Switchboard SB-22A/PT
1 Telephone Set TA-312/PT
1 Teletypewriter Set TT-98/FG
1 Telegraph Terminal TH-22/TG

Technical Characteristics

POWER REQUIREMENT --------- 115V, 50 to 60 Hz, 3,500W
WEIGHT ------------------- 997 kg (2,200 lb)
VEHICULAR REQUIREMENTS ---- One 1-1/4 ton truck

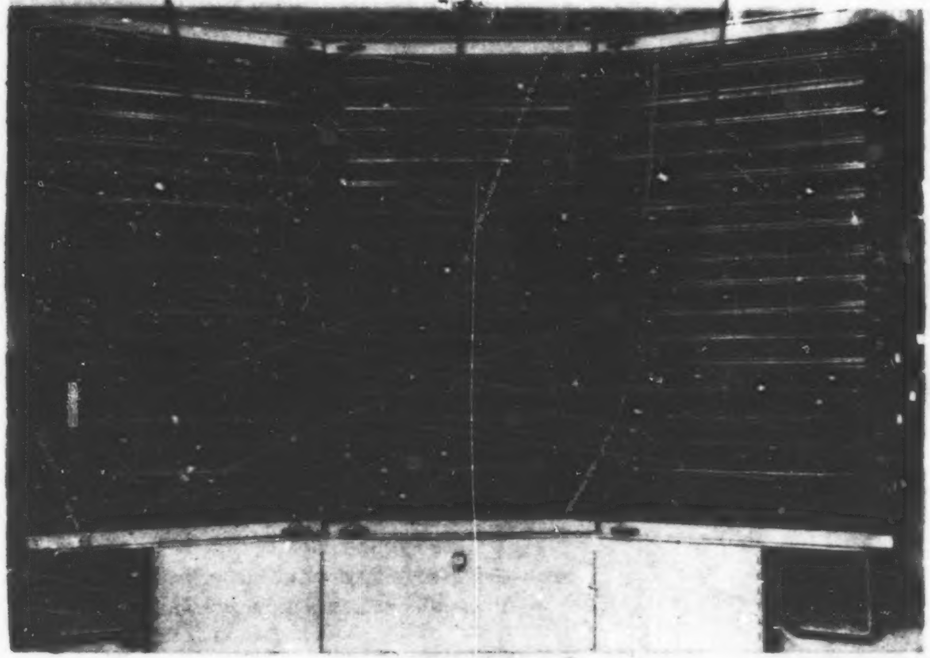

Figure 10-22. Patching Panel AN/TSC-76.

a. Jack Field Section

Control	Use
Line selector switch	M position: Prepares line circuit for use as magneto line or trunk. On lines 29 and 30 only, prepares line circuit to be used as civilian trunk as well as magneto line or trunk.
	C position: Prepares line circuit for use as common battery signaling line.
	T position: Prepares line circuit for as a common battery signaling trunk.
CIV TRKS switches (civilian trunk switches lines 29 and 30) (fig. 22).	Off postion: Permits connection of any type of line except a civilian truck to lines 29 and 30.
	ON position: Permits connection of civilian trunk to lines 29 and 30.
N.A. switch (night alarm switch)	OFF position: Turns off night alarm when not in use.
	AUD position: Provides buzzer as night alarm signal for operator when line signal turns white.
	VIS position: Panel lamps light when line signal turns white. This provides a visual night alarm signal for the operator. The panel lamps connot be used for lighting purposes when they are used as a night alarm.
LAMPS switch	On position: Turn panel lamps of the switchboard.
	OFF position: Turns panel lamps off when they are lighted.
Line signals (1-30)	Black position: Normal position of line signal. Indication to operator that the line needs no attention.
	White position: Operated position of line signal. Indication to operator that a party wishes to make a call.

Control	Use
Line jacks (1-30)	Permits connection of cord circuit to the line.
b. Keshelf Section	
Cord circuit switches	TALK LIST position: permits operator to talk and listen during progress of call. CONF. position: Connects cord circuits for conference call.
Answer supervisory signal	Turns white to indicate completion of call on associated answer cord. Provides supervision for all cord.)
Call supervisory signal	Turns white to indicate completion of call on call cord. (Provides supervision for call cord.)
Answer cord	Used to answering incoming call.
Call cord	Used to connect to called line.
Ringing circuit switch	RING BACK position: Sends ringing current over the answer cord. RING FWD position: Sends ringing current over the call cord.
CONF SUPV-TRK SIG swicth	CONF SUPV postion: Talk and listen on conference calls. TRK SIG position: Permits operator to signal on common battery signaling trunks (line selector switch in T position).
TALK BATT. switch (talk battery switch).	On position: Connects battery to the operator's telephone set. OFF position: Removes battery from the operator's telephone set.
Hand generator	Supplies ringing current for manual ringing.

Control	Use
BATT. CHECK switch (internal-external	Use INT. position: sets up power pack circuit to draw power from internally installed batteries. EXT. position: Sets up power pack circuit to draw power from external 24-volt battery bank.
BATT. CHECK switch (battery check switch).	Position 1: Places voltmeter across the upper battery bank in the power pack. Position 2: Places voltmeter across the lower battery bank in the power pack.
INT. SWBD BATT. (internal	LOW positon: Provides four Batteries BA-200/U in upper battery bank (internal battery only) for battery supply to switchboard. HI position: Adds fifth Battery BA-200/U to upper battery bank to provide limited control of voltage.
Voltmeter------------------------------	Indicates voltage of internal batteries when BATT. CHECK switch is operated.
Indicator lamp-------------------------	Lights when vibrator is operating.

Shunt Binding Posts.......... To replace Batteries VA-200/U in the power pack without interrupting the operation of the switchboard, follow the procedure below: (1) Connect a piece of wire between the SHUNT binding posts on the power pack. (2) Replace the upper and then the lower bank of batteries. DO NOT replace both banks of batteries at the same time. (3) Remove the wire from the SHUNT binding posts as soon as both banks of batteries have been replaced. Using one bank of batteries for the ringing supply and the signaling battery causes interference each tie ringing current is used. (4) Place the power supply chassis in the case and lock the four trunk-type latches on the sides of the power pack case.

10-24. CONNECTING ANS SWITCHING KIT MX-155/GT

The connecting and switching kit MX-155/GT (fig 10-23) provides a quick and simple means of establishing an intercommunication system at the gun position of a firing battery. It provides a rapid means of connecting individual or conference telephone circuits between the battery operations center (BOC), the battery fire direction center, the aiming circle position, and each gun position. The kit is designed for use with wire equipment already issued to the battery and is issued to most types of field artillery units. This disscussion is limited to its use with a six-gun battery.

a. Description of components. The following items are issued as components of the telephone connecting and switching kit MX-155/GT:

(1) Jack panel SB-16/GT. The jack panel SB-16/GT is a metal panel with two brackets for quick attachment or installation. The jacks are internally connected to form two separate circuits as followa:

(a) Jacks labeled ADJ GUN and EXEC, wired in parallel for one circuit provide facilities for an individual conversation between any two parties.

(b) Jacks labeled EXEC, ASST EXEC, and 1, 2, 3, 4, 5, and 6, wired in parallel, are for the firing battery circuit.

(2) Reel bracket. The reel bracket provides a means of mounting cable reel DR-8 in a swivel mounting to permit field wire to be drawn out freely in any direction. The connecting swivel mounting permits wire to be drawn out freely in any direction. The connecting and switching kit, MX-155/GT con- tains seven reel brackets. One is mounted on the trail or in the vicinity of each of the six guns and one is mounted at the battery operations center (BOC).

(3) Jack U-17/GT. Seven jacks U-17/GT are issued with the kit and are mounted on the cable reel DR-8. These jacks provide a plug-in type of connection for the telephones at the guns.

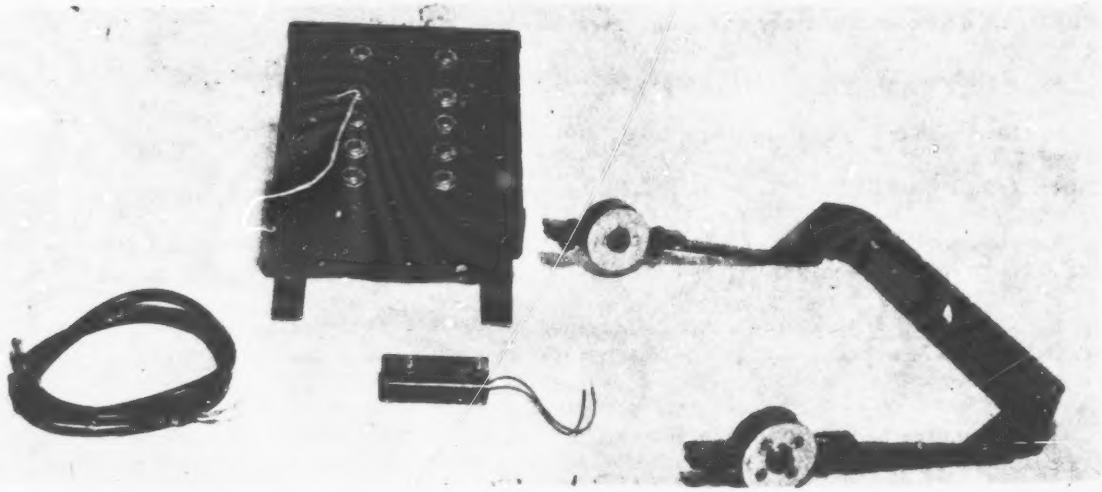

Figure 10-23. Connecting and switching kit, MX-155/GT.

(4) Cord CX-231/GT. Cord CX-231/GT is a 36-inch, two-conductor cord with one end terminating in a plug and the other end bared 3 inches for connection to field wire. Fifteen cords are issued with the kit. Six are used at the guns and nine are used at the jack panel.

(5) Other items. In addition to the components of the connecting and switching kit, MX-155/GT, the following TOE items are required for operation of the MX-155/GT:

(a) Seven cable reels DR-8.

(b) Modified, hand, cable reeling machine RL-39.

(c) Sufficient field telephones (minimum of seven) to allow the desired circuit arrangements.

b. Installation.

(1) Install the jack panel SB-16/GT near the battery center and to the rear but between guns 3 and 4.

(2) Lay a wire from each gun to the jack panel by pulling the wire off the modified reel DR-8, which remains mounted at the gun. Since the cord CX-231/GT is permanently spliced to the running end of the wire line, complete the connection by simply plugging the cord into the appropriate jack on the jack panel.

(3) Connect the bared end of the cord CX-231/GT to the binding posts of the telephone at the gun. Extend this cord, when necessary, by splicing in field wire WD-1/TT. Connect the telephone to the circuit by plugging the cord CX-231/GT into the jack on the modified reel DR-8.

Section IV. TELEPNONE DIRECTORY

10-25. INTRODUCTION

To effectively utilize the wire communication available to a unit, all personnel who use wire communication must be familiar with the procedures and techniques involved in its instalation and operation. Therefore, communication personnel must know and be able to teach other personnel the composition or preparation, purpose and use of the following:

a. A telephone directory and field telephone procedure.

b. Traffic diagram, circuit diagram, and line route map.

c. Switchboard operating procedures and techniques.

10-26. COMPOSITION

The telephone directory consists of two main parts--directory names and directory numbers. Its purpose is to simplify and expedite telephone switching service.

a. Directory names. Telephone directory names are assigned to all units equipped with a switchboard. They are changed only when there is a chance of confusion with directory names of other units.

b. Directory numbers. Directory numbers are assigned to the local telephones installed within a headquarters or installation. Directory numbers, once assigned, remain fixed.

10-27. PREPARATION

The military telephone directory is prepared for all units within a division by the division signal officer and published in the division communications-electronics operation instructions. Telephone directory names as assigned as described in a through c below:

a. Major units. Directory names of all major units in a division normally begin with the same letter. For example:

Directory Name	Unit
KING KONG	19 Inf Div
KAISER	1 st Bde, 19th Inf Div
KAPOK	19th Inf Div Arty
KEMP	2d Bn, 66th Inf
KENNEL	2d Bn, 45th FA
KEEL BOAT	2d Bn, 47th FAb.

b. Separate units. Separate battalions and companies or batteries that are not organic to a battalion are assigned separate directory names; for example:

Directory Name	Unit
KINKY	19th Engr Bn
KITCHEN	19th Sup and Trans Bn
KILT	19th Avn Bn
KAZOO	19th MP Co

c. Companies and batteries. Each organic unit at company or battery level will use the directory name of its parent battalion plus the suffix ALFA, BRAVO, CHARLIE, etc; for example:

Directory Name	Unit
KEMP ALFA	Co A, 2d Bn, 66th Inf
KITE STRING BRAVO	Co B, 2d Bn, 69th Inf
KETCHIKAN CHARLIE	Co C, 2d Bn, 70th Inf
KIDNAP ALFA	Btry A, 2d Bn, 49th FA
KRAGSHOT BRAVO	Btry B, 2d Bn, 46th FA

10-28. ASSIGNMENT OF TELEPHONE DIRECTORY NUMBERS

a. General. Telephone directory numbers, once assigned, remain fixed. To prevent confusion, the same number is prescribed for similar officers and offices throughout the command. A partial list of telephone directory numbers is shown below. A complete list is published for use in the unit communications-electronics operating instructions (CEOI).

Directory Numbers	Title
1	S1 or G1
2	S2 or G2
3	S3 or G3
4	S4 or G4
6	Executive officer or chief of staff
7	Commanding officer or assistant commander
11	Communication-electronics officer
12	Message center
14	Aide-de-camp
23	Forward observer
25	Liaison officer or fire support officer (FSO)
28	Radio station

b. Unlisted designators. Telephones not assigned directory numbers are identified by appropriate abbreviations or word descriptions; for example:

Designation	Installation
OP	Observation post
RADAR	Radar section

10-29. USE OF THE TELEPHONE DIRECTORY

A directory is provided for the user's convenience and must be used in accordance with a prescribed procedure. A directory name should not be used alone but always in conjunction with the appropriate number or designation of the installation being called; for example:

Directory Designation	Installation
KAPOK 7	CO, 19th Inf Div Arty
KEEL BOAT 7	CO, 2d Bn, 47th FA
KENNEL 6	XO, 2d Bn, 45th FA
KAPOK RADAR	Radar section, 19th Inf Div Arty

Section V. TELEPHONE PROCEDURE

10-30. GENERAL.

The principal advantage of telephone communication is that permits personal contact between two or more individuals. Conversations should be as short as possible and should be planned in advance.

10-31. PRECEDENCE OF TELEPHONE CALLS

Telephone calls are classified as urgent or routine.

a. Urgent calls. An urgent call is one that is given precedence over existing circuits to the extent that it will interrupt connections already made. However, one urgent call will not normally interrupt another urgent call already in progress. Urgent calls are reserved for reports containing information that may materially affect plans or change a course of action. Only personnel designated by the commander are normally authorized to place urgent calls; however, in an emergency, anyone may do so. Urgent calls are used to transmit such informatin as reports of intitial contact with the enemy, amplifying or subsequent enemy contact reports, and artillery fire missions.

b. Routine calls. Routine calls have no precedence but are handled in the order in which they are received by the operator. Routine calls constitute the bulk of the traffic handled over a military wire system. They may contain routine information which, although important, does not require special handling. All personnel using the military telephone system authorized to place routine calls.

10-32. WORDS AND PHRASES USED IN PLACING A TELEPHONE CALL

When placing or answering calls in the military telephone system, personnel are required to conform to a specific procedure, which includes the use of certain words and phrases. Switchboard operators should not be required to look up telephone directory names and number of the party to be called, the caller should refer to the directory before placing the call with the switchboard operator.

a. Urgent calls. In placing an urgent call, the calling party initiates the call, using the operating phrase URGENT CALL FOR. He than announces the called party's telephone directory name and number followed by the operating phrases THIS IS and his official designation. An urgent call from the C-E officer, 2d Bn, 45th FA, to the battalion commander would be announced to the switchboard operator as follows: URGENT CALL FOR KENNEL 7 - THIS IS THE COMMUNICATIONS-ELECTRONICS OFFICER.

b. Routine calls. In placing a routine call, the calling party announces to the switchboard operator the directory name and number of the called party. A routine call the the battalion S3 would be announced to the switchboard operator as KENNEL 3. A call for an unlisted telephone, such as the battalion observation post, 2d Bn, 45th FA, would be announced to the switchboard operator as KENNEL OP.

10-33. WORDS AND PHRASES USED IN ANSWERING A TELEPHONE CALL

In answering telephone calls, the answering party should state the directory name and number of the telephone and his official designation as follows: KENNEL -7 COMMANDING OFFICER SPEAKING, KENNEL 3 - S3 SPEAKING, or KENNEL 3 - OPERATOR SPEAKING.

10-34. PERSON-PERSON CALLS

Person-to-person conversations follow no specific procedures with regard to operating words and phrases other than that used in placing and answering the call. The parties connected use normal conversational language. To save time and thereby obtain maximum use from the military telephone system the calling party should plan his conversation before placing the call.

10-35. TRANSMITTING AN ORAL MESSAGE

The transmission of an oral message differs from a person-to-person conversation in that the persons transmitting and receiving the message are usually not the originator and addressee; therefore, operating words and phrases should be used by both parties. Oral messages differ from written messages in that they are not formally written on prescribed message forms and not submitted to the message center for transmission.

a. When a message is to be recorded by the receiving operator, it should be preceded with the word MESSAGE. The calling party should then pause to permit the called party to prepare to record the message.

b. Radiotelephone procedure words such as READ BACK, I READ BACK, CORRECT, WRONG, SAY AGAIN, I SAY AGAIN, ROGER, OVER, and OUT are used by both parties when applicable.

c. Assume that the S3, 2d Bn, 48th FA, tells his operations sergeant to call the commanding officer, Btry A, 2d Bn, 48th FA and give him the following information: HAVE SURVEY DETAIL CONSISTING OF FOUR MEN AND ONE VEHICLE REPORT TO POINT XRAY AT 1320 SIERRA. The operation sergeant, using the S3 telephone, rings the switchboard operator and says KARO ALFA 7.

d. The switchboard operator puts the call through, and the battery commander's operator answers KARO ALFA 7 - OPERATOR SPEAKING.

e. The operations sergeant then transmits: I READ BACK - THIS IS KARO 3 - OPERATIONS SERGEANT SPEAKING - MESSAGE FOLLOWS - READ BACK - HAVE SURVEY DETAIL CONSISTING OF FOUR MEN AND ONE VEHICLE REPORT TO POINT XRAY AT 1320 SIERRA - OVER.

g. The message is read back correctly, and the operations sergeant transmits CORRECT - OUT.

h. Assume that the receiving operator reads the message back to indicate that the survey detail is to report to point ALFA. The operations sergeant would correct the error by transmitting WRONG - WORD AFTER POINT - XRAY - OVER. The receiving operator would then transmit WORD AFTER POINT - XRAY - OVER. The operations sergeant should terminate the transmission by transmitting CORRECT - OUT.

Section VI. SWITCHBOARD OPERATION

10-36. IMPORTANCE

The success of an artillery unit in combat depends on reliable communication at all echelons. When available, wire communication is used to the maximum extent between these echelons. The switching central provides flexibility to the wire system and is the heart of the wire system. Therefore, military personnel should become familiar with the operating phrases and techniques applicable to switchboard operation. It is primary importance that all switchboard operators and communicationpersonnel use a standardized procedure and method of operating the switchboard. It is important for operators to listen in on connections from time to time in order to supervise, but they must not listen in for any other purpose. Under security regulations they would be subject to unauthorized disceplinary action. Officers, particularly company grade, should be familiar with switchboard operating techniques and procedures, since the bulk of the instruction and training on this subject is conducted by them or under their supervision.

10-37. PHRASES USED IN ANSWERING CALLS

If the telephone service is to run smoothly, all operators must use the same procedure. A complete list of words and phrases to be used by operators for all types of operation is published in ACP 134(A). A partial list of the more commonly used operating phrases is presented below in paragraphs 30, 31, and 32.

a. KENNEL OPERATOR--In answering an incoming call, the switchboard operator will repeat the telephone directory name followed by the word OPERATOR:

b. KENNEL 7--On receiving the number from the calling party, the switchboard operator will repeat the telephone directory name and number exactly as it was given him by the calling part.

c. WHAT NUMBER PLEASE--Used by the operator to request repetiton of a number that he has not understood.

d. THE LINE IS BUSY--Used by the operator to report that a local telephone, for which he has received a call, is already in use or that all trunks to a desired central are in use.

e. KENNEL 7 - URGENT CALL--On receiving an urgent call, the switchboard operator will repeat the telephone directory name and number followed by the phrase URGENT CALL.

f. CONFERENCE CALL - KENNEL 7 - KRAGSHOT 7 - KIDNAP 7 - I WILL CALL YOU BACK--Used by the operator to indicate that he has understood correctly the numbers given him by the calling party, and that, after completing the calls, he will call the originator back as requested.

g. CONFERENCE CALL--KENNEL 6 - KENNEL 3 - KENNEL 2 - ONE MOMENT PLEASE--Used by the operator to indicate that he has understood correctly the number given him and to hold the calling party on the line while the connection is being completed.

10-38. PHRASES USED IN CALLING AND SUPERVISION

The switchboard operator uses certain phrases in calling to hold a party on the line to inform connected parties that the connection is complete, to supervise calls already connected, and under certain conditions, to interrupt a call made previously that is still in progress.

a. Trunk circuits. Assume that a call that requires routing over a trunk circuit is initiated by a local telephone connected to KENNEL switchboard. The following phrases are used under the indicated conditions. KRAGSHOT DOES NOT ANSWER is used by the operator to inform the calling party that the called switchboard (KRAGSHOT) does not answer. KRAGSHOT 6 is used by the operator to pass the number of the called party to the switchboard to which the called party is connected.

b. Urgent calls. I MUST INTERRUPT - URGENT CALL FOR KENNEL 7 is used by the operator to interrupt a local routine call and to inform the connected parties which one is desired for the new connection. I MUST INTERRUPT - URBENT CALL FOR KENNEL 7 - PLEASE HANG UP is used by the operator to complete an urgent call through another switchboard when the trunk connection is in use.

c. Conference calls. CONFERENCE CALL FOR YOU - ONE MOMENT PLEASE is used by the operator to inform the called party that he has a conference call and that there will be a delay in completing the connection. YOUR CONFERENCE CALL - GO AHEAD PLEASE is used by the operator to inform the calling party that the connection is complete and conversation may begin.

d. Supervision. HAVE YOU FNISHED is use by the operator in supervising a connection. If no reply is heard, the operator should repeat the challenge. I WILL RING AGAIN is used by an operator when, in supervising a connection, he is informed that he called party did not answer. WHAT IS YOUR NUMBER PLEASE is used by an operator if, after supervising a connection, he is given a new number to call by one of the parties but is unable to identify the calling party.

10-39. COMPREHENSIVE ILLUSTRATION OF WORDS AND PHRASES

The following examples illustrate the operating technique combined with the operating words and phrases. The two combined (i.e., knowledge of operating technique and use of operating words and phrases) consitute the proper method of switchboard operation.

a. Trunk call. The division artillery commander wishes to talk to the commanding officer 2d Bn, 45th FA, after determining the directory name and number of the party to be called from the telephone directory, he places the call.

Div arty cmdr: Rapidly turns generator handle of telephone several times.
KAPOK opr: KAPOK OPERATOR.
Div arty cmdr: (Slurs the call) KENNEL 7.
KAPOK opr: WHAT NUMBER PLEASE.

Explanation: The switchboard operator fails to understand the called number and uses the proper operating phrase WHAT NUMBER PLEASE to inform the calling party that he failed to understand him and that a repetition of the called number is desired.

Div arty cmdr: KENNEL 7
KAPOK opr: KENNEL 7

Explanation: The switchboard operator at division artillery (KOPOK) receives the called number correctly and proceed to place the call through the desired trunk circuit.

KAPOK opr: Rings KENNELS operator.
KENNEL opr: KENNEL OPERATOR.
KAPOK opr: KENNEL 7.

Explanation: The KENNEL operator completes the connection between the calling and called parties. When the converstation is finished, both parties ring off. The division artillery commander desires another number.

KAPOK opr: HAVE YOU FINISHED - HAVE YOU FINISHED.
KENNEL opr: HAVE YOU FINISHED - HAVE YOU FINISHED.
Div arty cmdr: NO, I WANT KAPOK 3.
KAPOK opr: KAPOK 3. WHAT IS YOUR NUMBER PLEASE.
Div arty cmdr: THIS IS KAPOK 7.
KAPOK opr: ONE MOMENT PLEASE.

Explanation: Both switchboard operators are alerted when the connected parties ring off. Each challenges the circuit with the proper phrase (HAVE YOU FINISHED? HAVE YOU FINISHED?) to make sure that no further service is desired. The trunk circuit between switchboards is still connected; therefore, both operators are able to hear any new request that may be desired. In this case, the KAPOK operator took the initiative, repeated the called number, and then used the phrase WHAT IS YOUR NUMBER PLEASE to determine which of the original talking parties desired the new number. The KAPOK operator then used the phrase ONE MOMENT PLEASE to hold the calling party on the line while he made the necessary connection. The KENNEL operator listening in knows that he can be of no further service and breaks the connection at his switchboard. Let us assume that the KAPOK 3 circuit is in use. The switchboard operator would inform the division artillery commander by saying--

KAPOK opr: THE LINE IS BUSY.

b. Conference call. The division artillery commander wants a conference call with his S3 and the battalion commander, 2d Bn, 45th FA.

Div arty cmdr: Rapidly turns generator handle of telephone several times.
KAPOK or: I WANT A CONFERENCE CALL WITH KAPOK 3 AND KENNEL 7 - THIS IS THE COMANDING OFFICER - CALL ME BACK.
KAPOK opr: CONFERENCE CALL - KAPOK 3 - KENNEL 7 - I WILL CALL YOU BACK.

Explanation: The switchboard operator (KAPOK) calls each party in the order in which their numbers were given him by the orginator of the call. If more than one party is desired at another switching central, the originator switchboard operator should require the distant switchboard operator to accomplish these calls and then call him back.

KAPOK opr:	Rings KAPOK 3.
S3:	KAPOK 3 - OPERATIONS OFFICER SPEAKING.
KAPOK opr:	CONFERENCE CALL FOR YOU, ONE MOMENT PLEASE.
KAPOK opr:	Rings on KENNEL trunk.
KENNEL opr:	KENNEL OPERATOR.
KAPOK opr:	KENNEL 7.
KENNEL opr:	KENNEL 7. Rings KENNEL 6.
Bn cmdr:	KENNEL 7 - COMMANDING OFFICER SPEAKNG.
KAPOK opr:	CONFERENCE CALL FOR YOU - ONE MOMENT PLEASE.

Explanation: When assured that both parties are connected to the conferencecircuit, the operator recalls the originating party.

KAPOK opr:	Rings the commanding officer's circuit.
Div arty cmdr:	KAPOK 7 - COMMANDING OFFICER SPEAKING.
KAPOK opr:	YOU CONFERENCE CALL - GO AHEAD PLEASE.

Explanation: When the conference between the connected parties is finished, all parties ring off. Both switchboard operators challenge the circuit.

KAPOK opr:	HAVE YOU FINISHED - HAVE YOU FINISHED.
KENNEL opr:	HAVE YOU FINISHED - HAVE YOU FINISHED.

Explanation: If there is no reply to the challenge the switchboard operators will break the connections.

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Section VIII. CONSTRUCTION, RECORDING, AND RECOVERY OF WIRE LINES

10-40. PLANNING AND ROUTING WIRE LINES

The planning of wire lines should include the type of line and general route to be followed. the transmission characteristics of field wire when laid on the ground, buried or installed on overhead supports should also be considered. Generally, overhead construction gives linger transmission ranges and provides more physical protection than any other type of construction. The time element may limit the use of overhead construction initially, in which case the wire is laid hastily on the ground. Wire lines laid rapidly on the ground without regard for servicing require immediate and continous maintenance. On the other hand, surface lines laid carefully, with due consideration to ties, crossings, and other means of protection, provide reliable circuits suitable for most combat requirements. The wire line may be laid with only a minimum of servicing initially to insure continous communications. Policing should be accomplished immediately. The selection of the route is based on the requirements of the tactical situation and on map and ground reconnaissance. Wire construciton among buildings should be avoided, since it is difficult to install and maintain the wire and since the presence of the wire may invite sabotage. Cross-country routes should be used when practical to minimize interruptions from friendly traffic, aerial bombardment, and, in some cases, artillery fire. If the situation warrants, wire trenches should be considered. The wire routes should, when possible, be concealsed from enemy observation.

10-41. WIRE SPLICES

Splicing is a method of joining conductors of wire lines to maintain continuity. There are two type os splices--the standard filed wire splice, which is made by use of the wire splicing ket MK-3566/G (figh 10-2), and the expedient field wire splice which is made by use of the tool equipment TE-33 (fig 10-3). A good splice can restore broken wire lines and prevent shorts, open circuits and grounded conductors. All personnel should be familiar with the construction of wire splices.

10-42. CONSTRUCTION OF FIELD WIRE SPLICE

a. First, prepare the conductors as indicated in figure 10-22. Preparing the ocnductors in this manner results in staggered splices, which prevent excessive bulk and eliminates the possibility of electrical contact between the conductors. Leave the insulation on the ends of the conductors to bind the strands of wire together until the square knots have been tied, as shown in figure 10-23. The the first knot and then restore the twist in the wire line by wrapping the two remaining untied conductors around the two conductors already tied. After restoring the twist, tie the second square knot so that communication will be possible before the splices are completed. Then remove the insulation from the ends of the conductors.

b. After removing the insulation from the ends of the conductors, separate the steel and copper strands as shown in figure 10-24. Then cut the steel strands even with the insulatin on the side of the knot to the side opposite that form which they protrude and wrap them around the knot until they extend two or three turns upon the insulation. The purpose of this is to improve the electrical contact, seize the knot so that it cannot slip, and bind the steel strands down against the conductors so that they cannot penetrate the tape to cause a ground or a short circuit.

c. Afte seizing the splices, tape them with electrical insulation tape TL-600/U or TL-636/U to prevent water seepage and short circuits. The taping procedure is indicated in figure 10-25. Remove the backing and stretch the tape to activate its self-bonding properties. Start taping at the center of the splice and, with a steady pull, wrap the tape out and upon the insulation for approximately 1 inch. Then wrap the tape back across the knot and 1 inch upin the insulation at the opposite end, wrap it back to the center, and tear off the excess. For added protection, apply friction tape. Starting approximately 1 inch upon the insulation, wrap the friction tape across the splice, extending it 1 inch upon the insulation at the opposite end to complete the splice.

d. If a wire line is accidentally broken and the necessary equipment to construct a wire splice is not available, us a bayonet or some other sharp instrument to prepare the wire so that it resembles as closely as possible the wire shown in figure 10-22. Tie the first square knot, restore the twist in the wire, and tie the second square knot. If tape is not available, raise the splices off the ground and separate them with a stick or twig to eliminate the possibility of electrical contact between the conductors. If sufficient equipment is not available to construct a permanent splice, mark the splice so that it will be easier to locate. Notify communication personnel of the location of the splice as soon as possible.

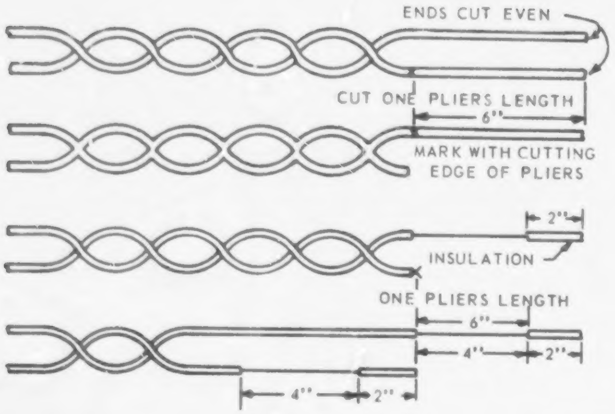
ENDS CUT EVEN
CUT ONE PLIERS LENGTH
6"
MARK WITH CUTTING EDGE OF PLIERS
2"
INSULATION
ONE PLIERS LENGTH
6"
4"
2"
4"
2"

Figure 10-22. Preparation of wire for splicing.

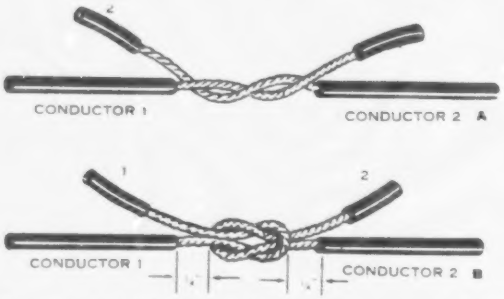
2
CONDUCTOR 1
CONDUCTOR 2 A
1
2
CONDUCTOR 1
CONDUCTOR 2 B
¼"
¼"

Figure 10-23. Typing the square knot.

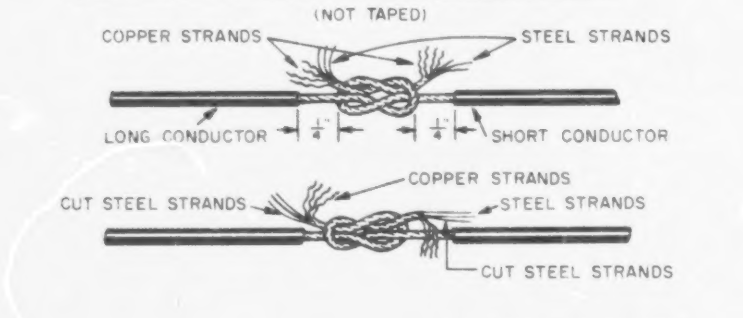
(NOT TAPED)
COPPER STRANDS
STEEL STRANDS
LONG CONDUCTOR
1/4"
1/4"
SHORT CONDUCTOR
COPPER STRANDS
CUT STEEL STRANDS
STEEL STRANDS
CUT STEEL STRANDS
2-3 TURNS ON INSULATION

Figure 10-24. Construction of the splice.

a. Clove hitch tie. When the end of the object to which the wire is to be tied is exposed so that the wire may be placed over it, the clove hitch tie (fig 10-27) may be used. This tie is useful for most field wire installations.

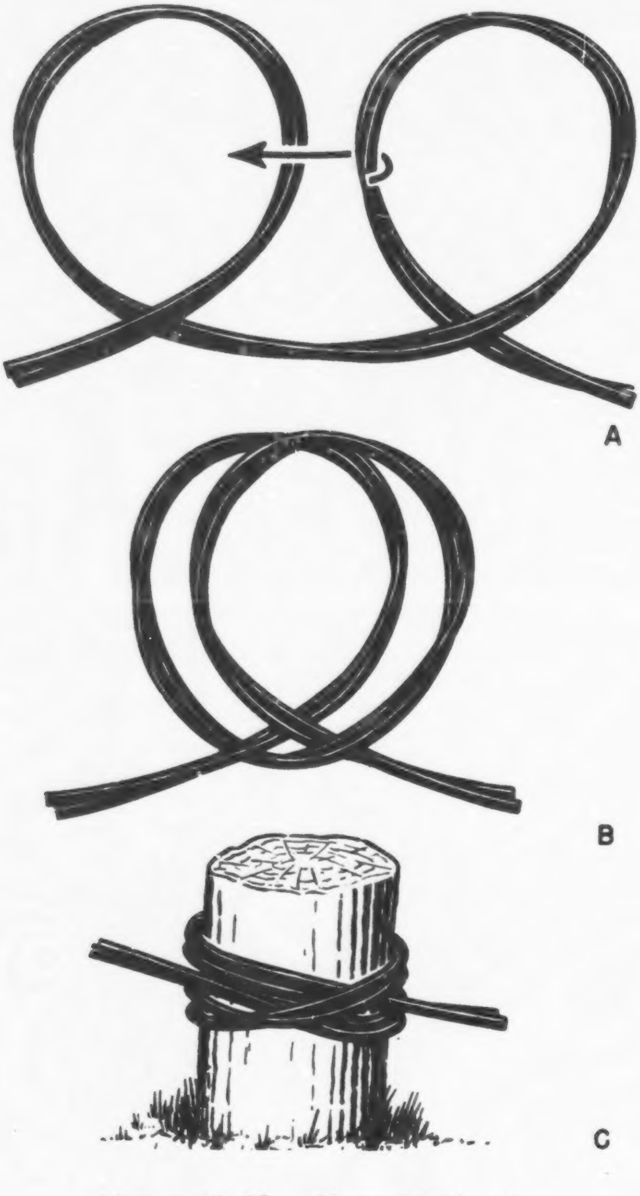

Figure 10-27. Clove hitch tie.

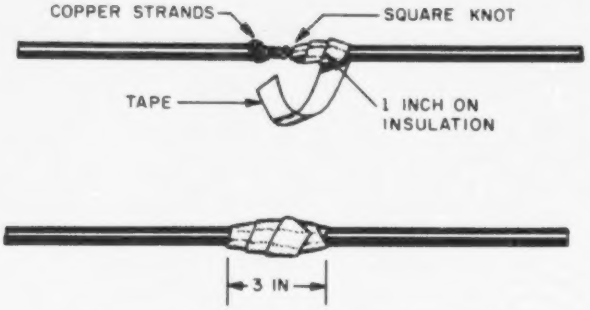

Figure 10-25. Taping the splice.

10-43. WIRE TIES

Field wire ties are used to hold wire lines in place at an abrupt change in direction and at all crossings and to relieve the strain on wire lines at their terminating points. The wire should be tied securely to a convenient tree, to an equipment D-ring, or to some other support before it is connected to the binding posts. Also, wire lines should be tied in at various points en route. As a general rule, there should be a tie every few hundred yards, or less if required. When wire is tied above equipment, a drip loop (fig 10-26) should be provided to keep water out of the terminal equipment. Some ties that may be used are as follows:

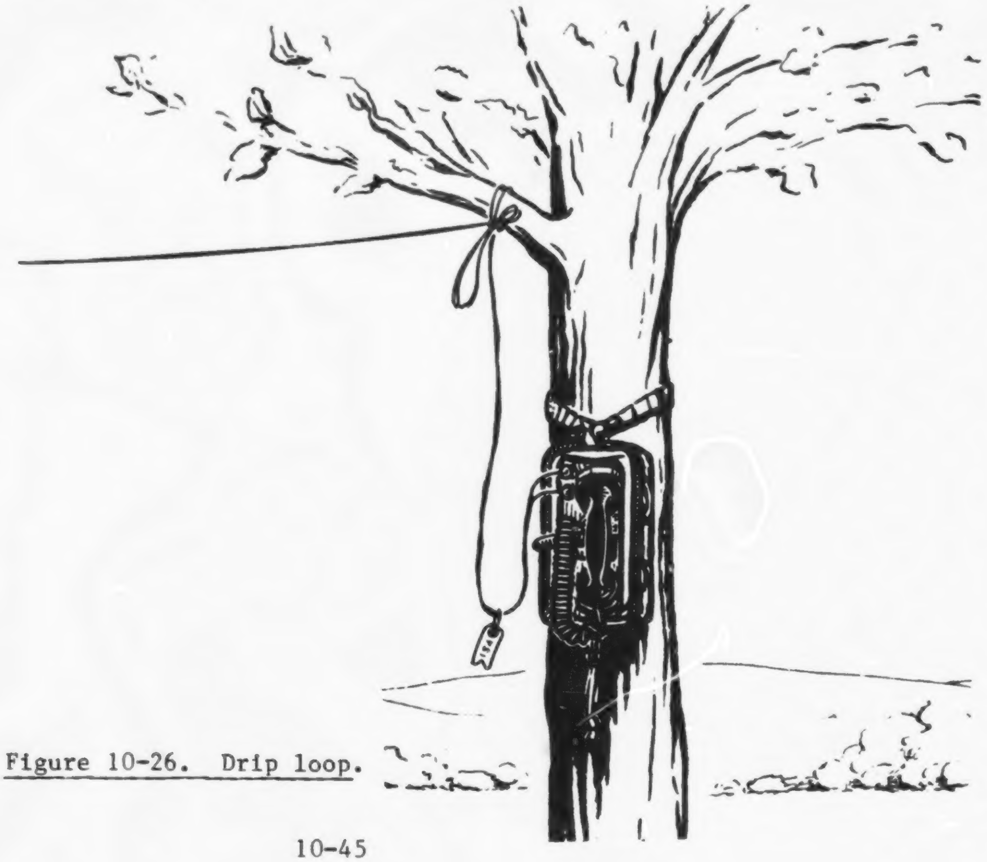

Figure 10-26. Drip loop.

b. Loop knot tie. The loop knot tie (fig 10-28) is satisfactory for hasty construction when wire is to be tied to an object and the end of the wire is not exposed. It should not be used in long or permanent spans or where it may be accidentally untied by passing personnel or vehicles.

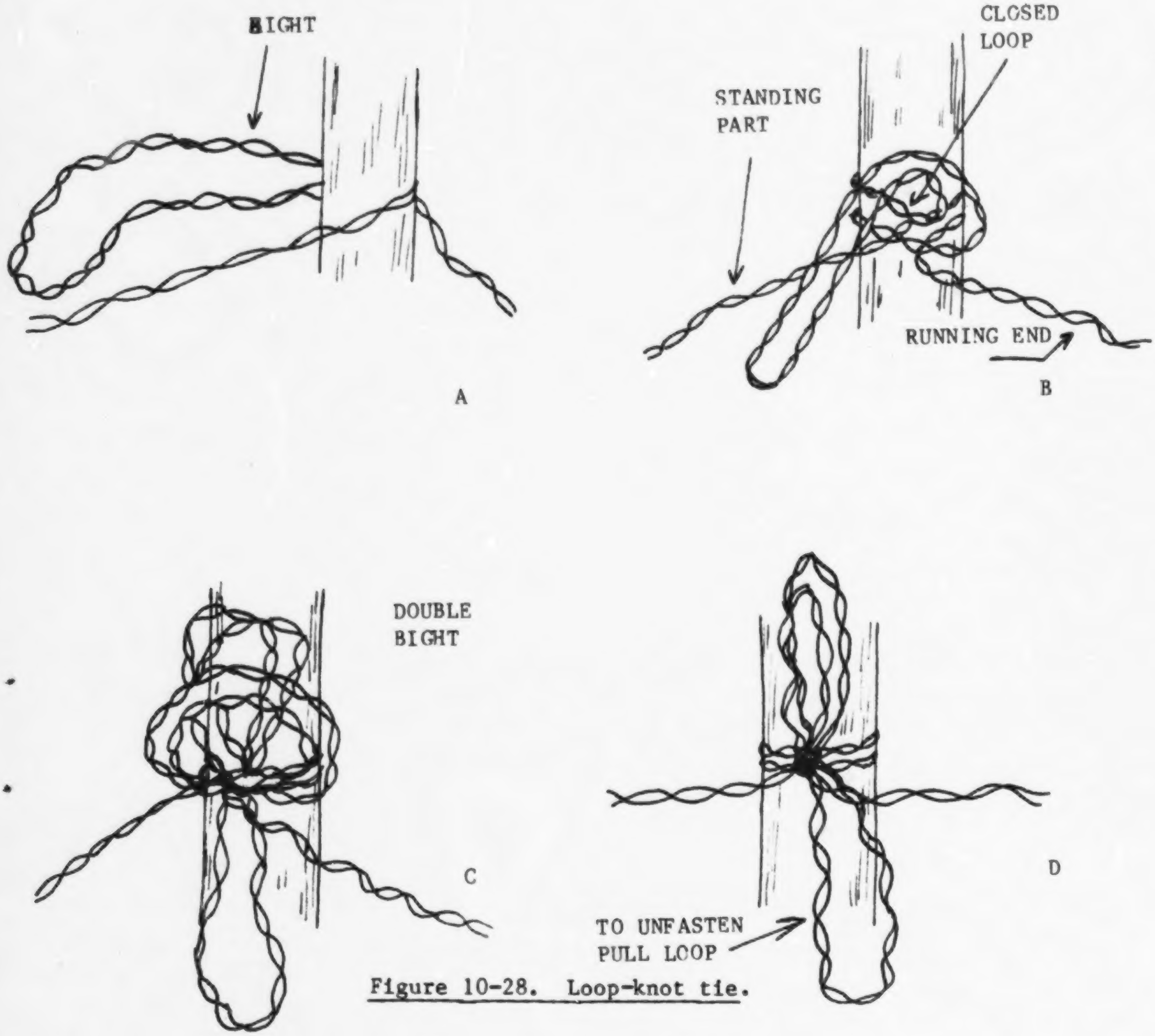
BIGHT
A
STANDING PART
CLOSED LOOP
RUNNING END
B
DOUBLE BIGHT
C
TO UNFASTEN PULL LOOP
D

Figure 10-28. Loop-knot tie.

c. Basket hitch tie. The basket hitch tie (fig 10-29, 10-30, 10-31) should be used as an aerial tie for field wire WD-1/TT for long spans, in all climates, under conditions of heavy wind or icing, and for permanent installations. This is the only aerial tie that should be used for wire.

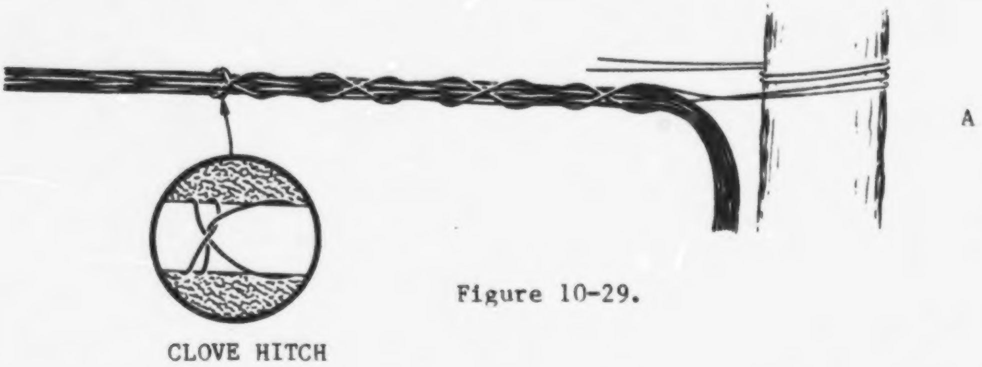
A
CLOVE HITCH

Figure 10-29.

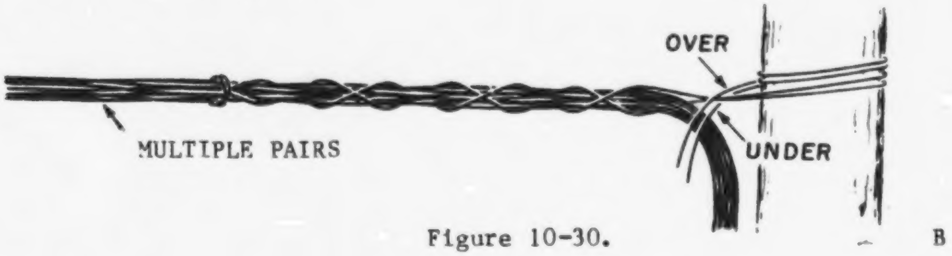
OVER
MULTIPLE PAIRS
UNDER
B

Figure 10-30.

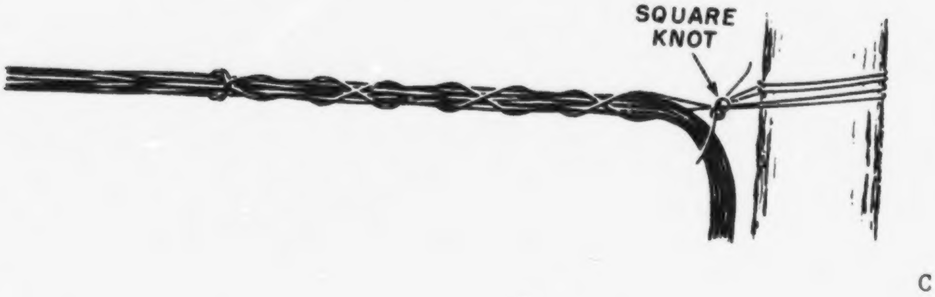
SQUARE KNOT
C

Figure 10-31. Basket hitch the tie at termination of aerial span.

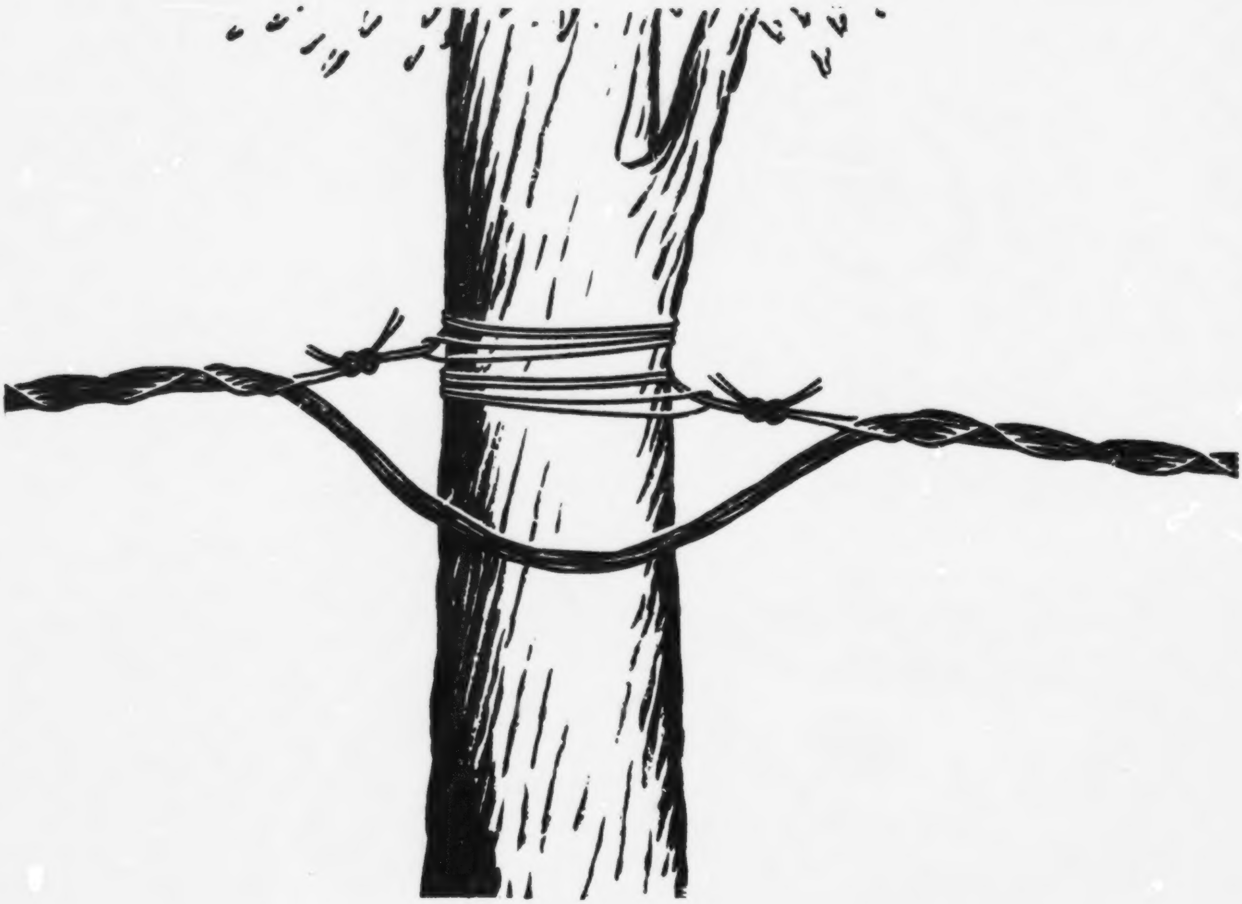

Figure 10-32. Basket hitch tie supporting aerial span.

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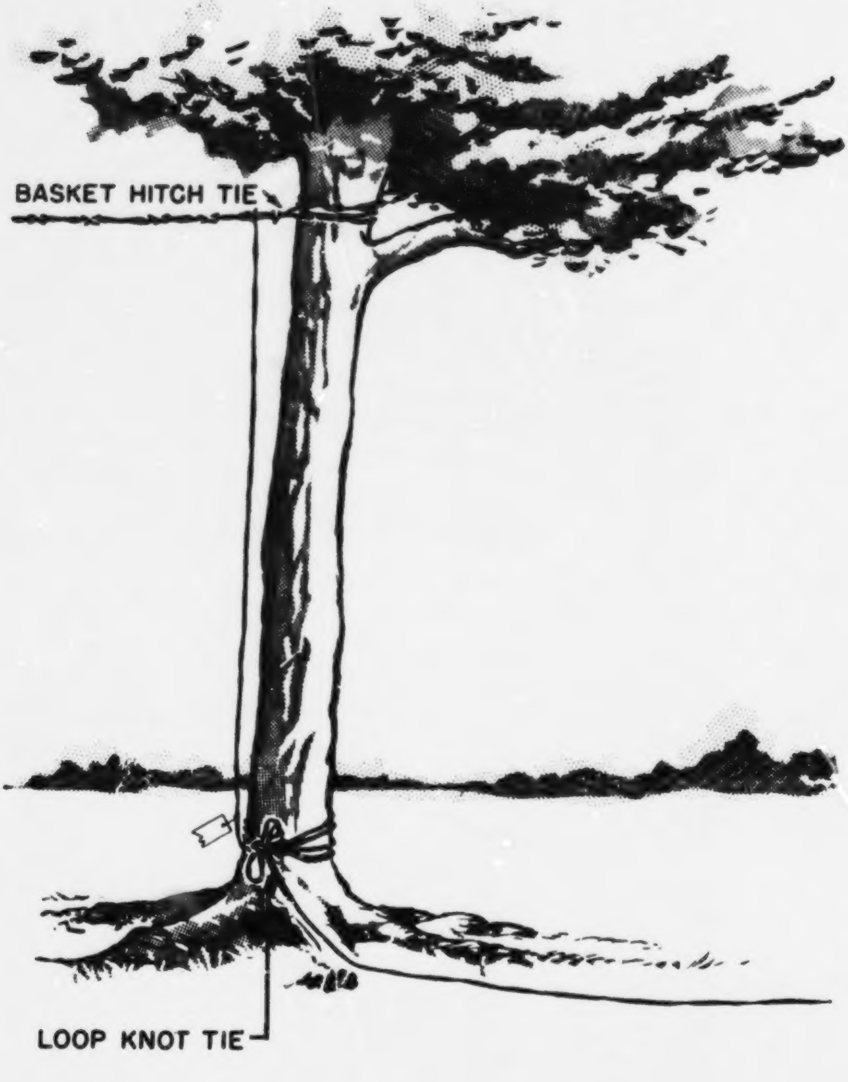

Figure 10-33. Method of tying wire lines at bottom and top support.

10-44. SURFACE LINE CONSTRUCTION

a. Basic considerations. During combat, field wire lines are laid hastily on the ground. Such lines are called surface lines. These lines must be protected from traffic at command posts, at road and railroad crossings, and at other places where they cross traffic lines.

Surface lines should be laid loosely, with plenty of well-distributed slack (approximately 20 percent) along the line. Slack allows the line to lie flat on the ground and simplifies maintenance and construction changes. Surface lines should be tied to trees or posts to prevent passing troops and vehicles from pulling the wire into traffic lanes. All ties should be made at ground level. Surface lines must be kept well off roads and road shoulders. The principal advantages of surface lines are that the lines require less time and fewer personnel for installation and, when laid loosely, are less vulnerable than overhead lines to artillery fire. The main disadvantages are that surface lines may become unserviceable in wet weather and are often broken by passing troops and vehicles.

b. Overhead construction.

(1) Wire should be placed overhead near command posts and congested troop areas, along roadways at points where traffic is likely to be diverted from the road, and at main and secondary road crossings where no culvert or bridge is available. When wire is placed on commercial poles or other poles carrying bare wire on crossarms or brackets, the wire should be placed below the lowest bare wire.

(2) When available lance poles provide a convenient method of supporting wire lines where trees, telephone poles, or other means of support are not available. The wooden lance pole PO-2 is 14 feet long and about 2 inches in diameter. For an overhead wire crossing on a secondary road the shoulders of which are higher than the crown, one lance pole on each side of the road may provide the minumum clearance of 18 feet. For crossing over a main traffic artery it may be necessary to lash two lance poles together (fig 10-32) to gain additional height. The poles should be lashed with minimum overlap of 5 feet, for a total height of 23 feet, which is well above the minimum requirement of 18 feet. When necessary to install wire lines on lance poles in a straight line, the span lengths should not exceed 100 feet and every 10th pole should be guyed four ways. If severe weather is expected, the distance between poles should be reduced. In all pole construction, adequate guying is of utmost importance. The wire line circuits are never used to guy lance poles, since this would place unnecessary strain on the conductors and increase the possibility of trouble. Salvage wire should be used to guy the poles, and the angle between the guy and the ground should be approximately 45° (fig 10-33).

(3) Sag in the line is an important factor in overhead wire construction, especially if trees are used as supports. There must be sufficient sag in the line to allow the supports to sway without breaking the wire line. Weather conditions, span length, and tensile strength of the wire are considered in determining the proper amount of sag. All lines tied to the same supports should have the same amount of sag. A good rule of thumb is 6 inches of sag for every 25 feet of span length.

10-45. CROSSINGS

a. Road crossings.

(1) Culvert. When a road must be crossed, wire should be passed through a culvert, if possible. When a culvert crossing is made, the wire is pulled against the top of the culvert, tagged, and tied to reduce the possibility of damage by brush or contact with water. If the wire makes a sharp bend at either end of the culvert, the point of contact must be wrapped with tape to protect the insulation. A culvert crossing is shown in figure 10-36.

(2) Overhead. If a culvert is not available, the next best crossing is an overhead crossing. The wire must clear the crowns of main traffic arteries and paved roads by at least 18 feet. Buildings or trees should be utilized, or, if nothing else is available, lance poles can be used (fig 10-34 and 35).

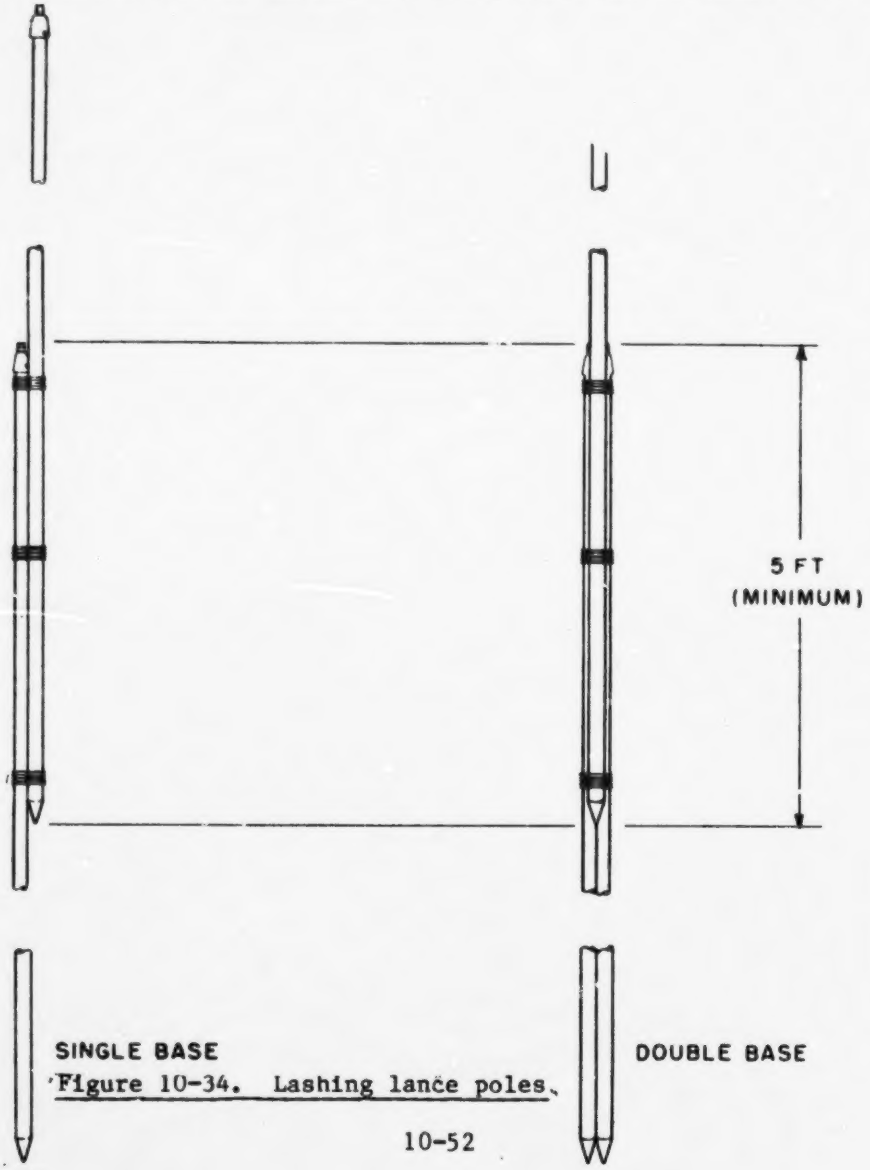

Figure 10-34. Lashing lance poles.

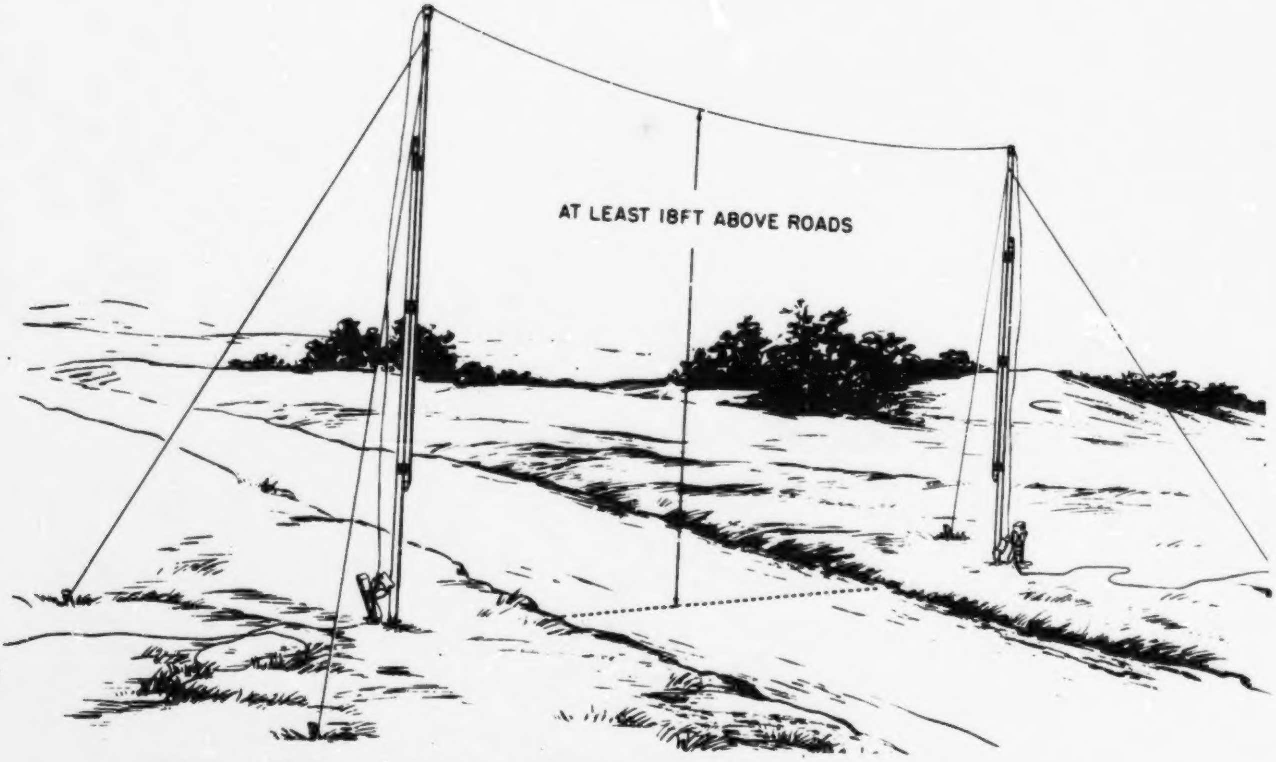
AT LEAST 18FT ABOVE ROADS

Figure 10-35. Lance poles used in wire construction across roads.

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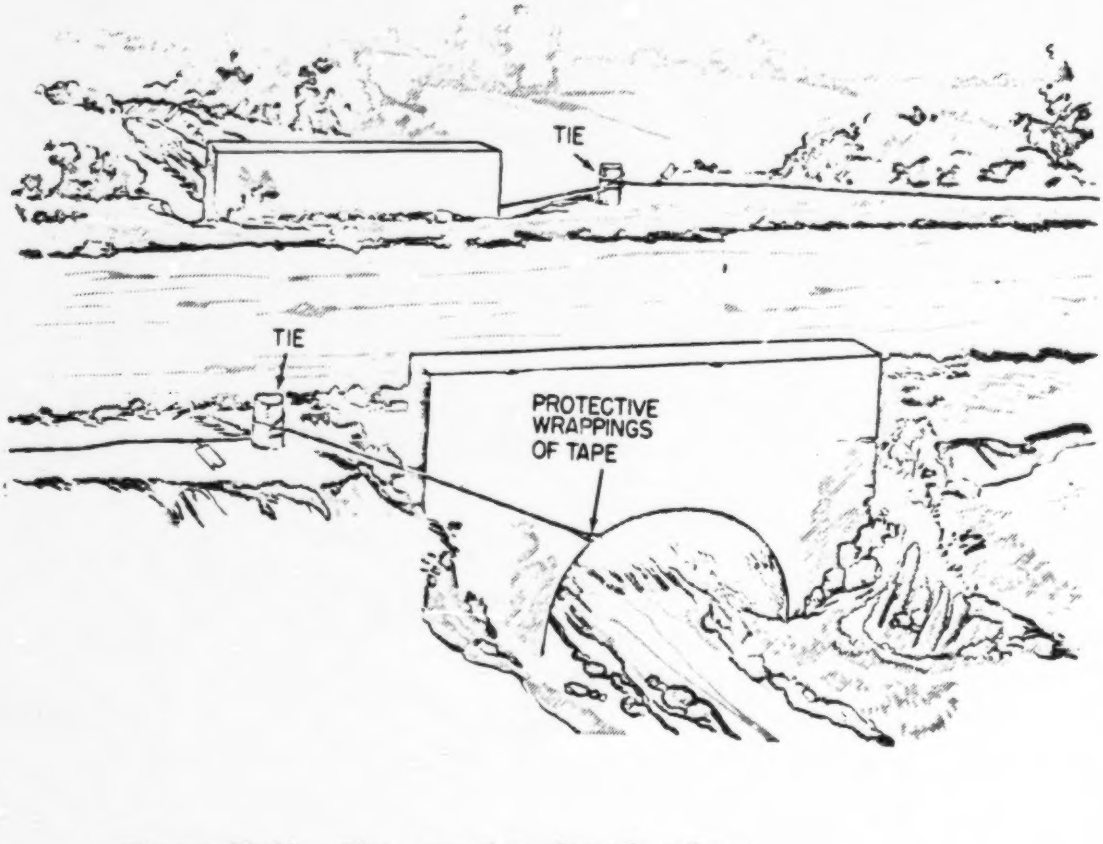

TIE
TIE
PROTECTIVE
WRAPPINGS
OF TAPE

Figure 10-36. Wire crossing through culvert.

(3) Underground. If a culvert or an overhead crossing cannot be made, the wire can be buried in a trench across a dirt road at right angles to the road (fig 10-37). The wire should be taut and should be tied and tagged at both ends. The trench should be 6 to 12 inches deep. In loose, sandy soil, a trench at least 3 feet deep is necessary to afford protection from tracked vehicles.

(4) Parallel. When a hard-surfaced road must be crossed and a culvert, overhead, or underground crossing cannot be made, the wire may be laid on the road as a last resort. A smooth section of the road should be selected, and a length of wire should be substituted for each conductor of the circuit crossing the road. This is known as a parallel crossing. Parallel crossings should be separated by a distance greater than the length of the longest vehicle that will use the road. The wire is laid without slack and is tied and tagged on each side.

b. Railroad crossing. When a railroad must be crossed, the wire should be laid under a bridge or through a culvert even if it is necessary to lay the wire parallel to the tracks for some distance. If a bridge or culvert is not accessible, wire lines should be laid under the rails (fig 10-38). The wire should be pulled taut and buried to a point beyond each shoulder or improved strip along the tracks. This measure prevents the wire from being pulled out and becoming a hazard to trainmen walking along the tracks. Wire lines should never cross railroads overhead because overhead wires endanger trainmen on top of the cars.

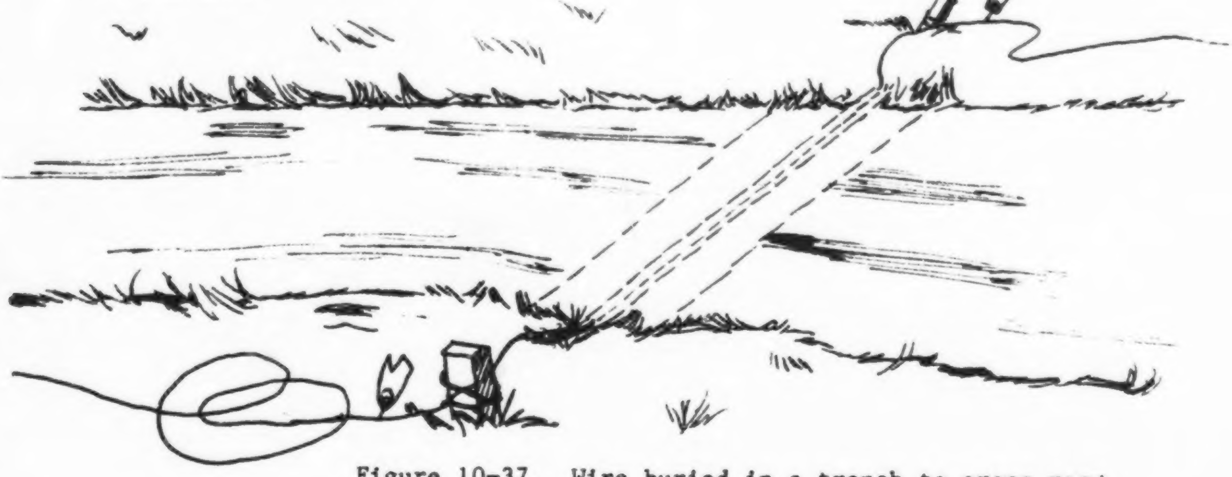


Figure 10-37. Wire buried in a trench to cross road.

c. River crossings.

(1) Overhead. Overhead crossings over small streams may be made in the same manner as overhead road crossings except that the wire need be only high enough to clear waterborne traffic. A span of more than 150 feet should not contain a splice. Long spans up to 250 feet can be made, but special construction is necessary for the wire to resist the strain (fig 10-39).

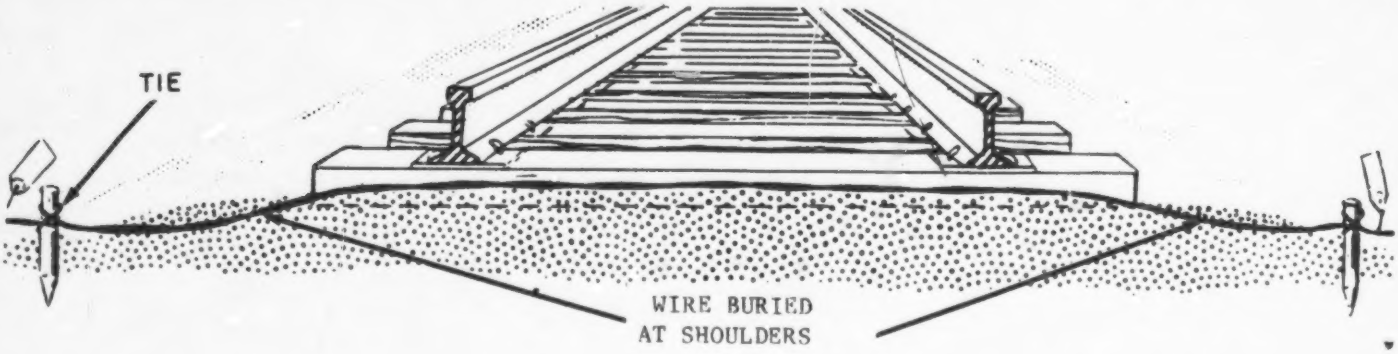


Figure 10-38. Wire crossing under railroad tracks.

(2) Submerged. Wire may be submerged when an overhead crossing is not practical (fig 10-40). Either new wire or wire with nearly perfect insulation should be used, since the circuit quality and the taking range decrease with the immersion time. The standard wire splice is not adequate for this type of installation. Only unspliced wire should be submerged. The line must be anchored to prevent abrasion if the current is greater than 2 or 3 miles per hour.

Notes. ____

SupR
80170

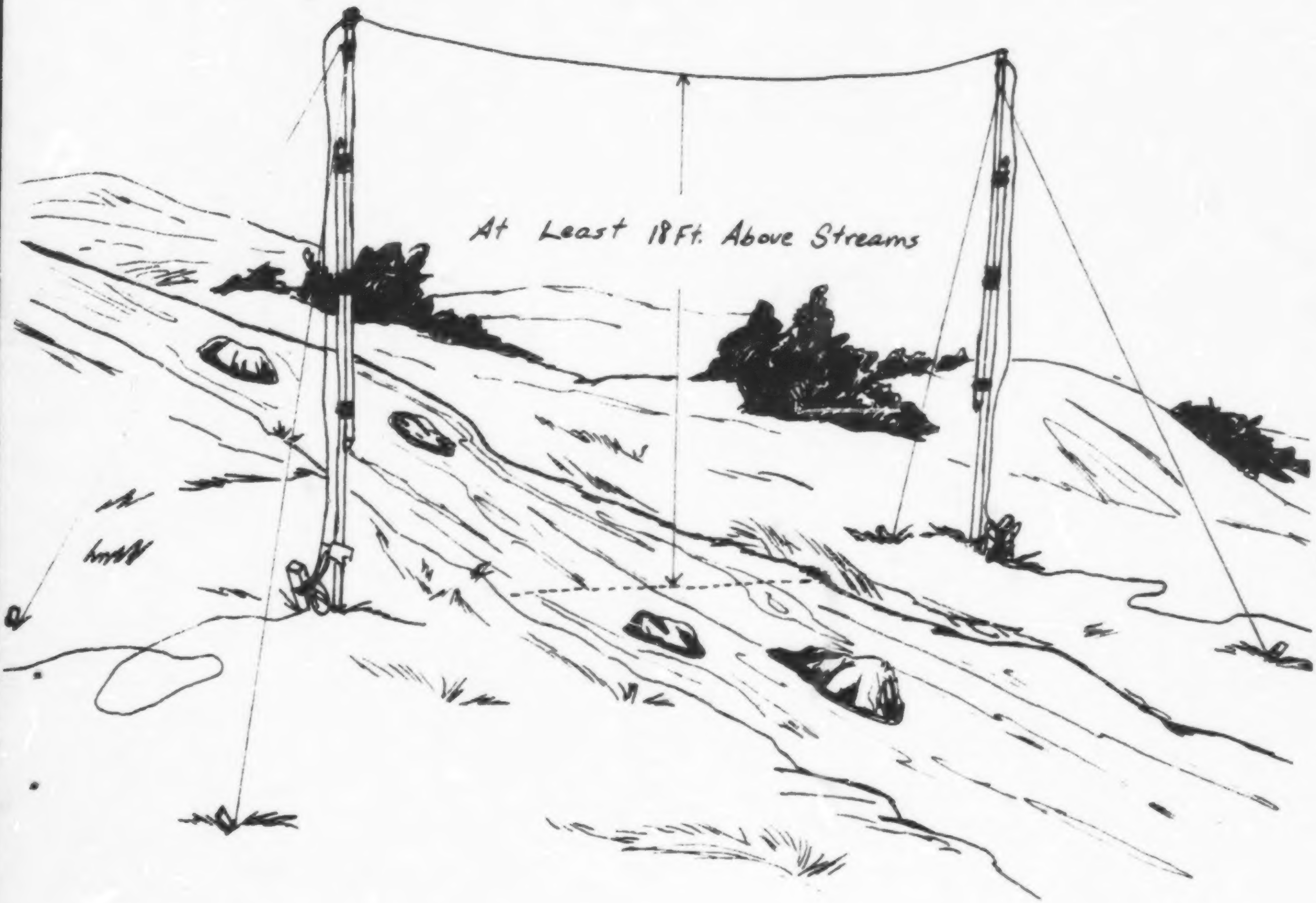

At Least 18 Ft. Above Streams

Figure 10-39. Wire construction overhead across stream using lance poles.

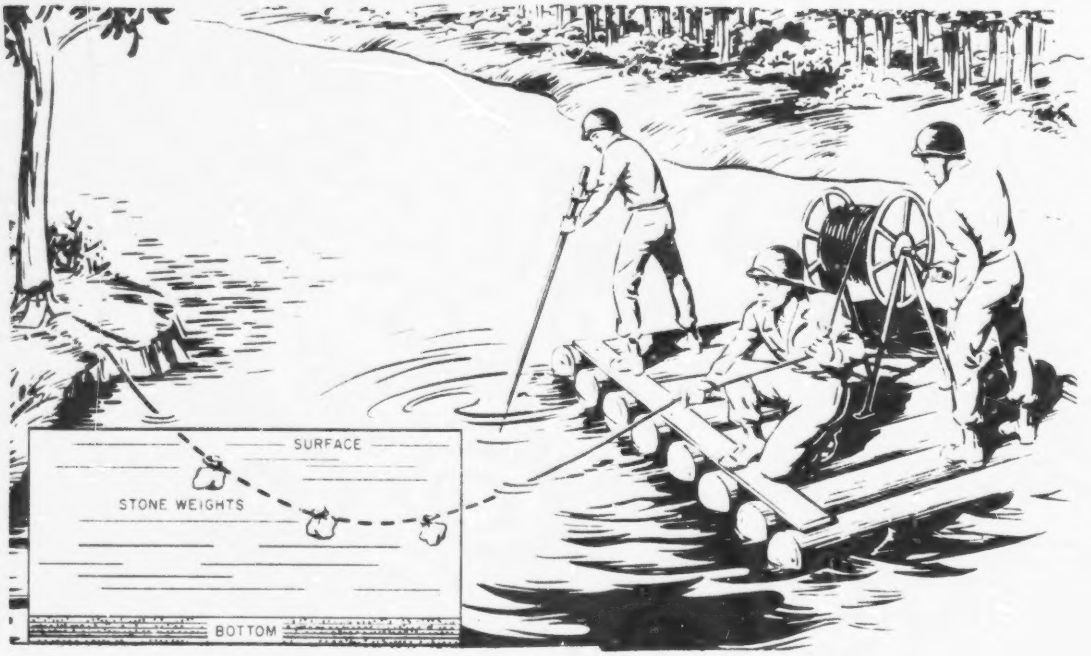


Figure 10-40

Section VIII. TRAFFIC DIAGRAM

10-46. DEFINITION

A traffic diagram is an illustration showing the number of telephone or teletypewriter circuits between switching the centrals of a wire system. Long local circuits may also be shown.

10-47. PREPARATION

A traffic diagram at battalion level or below is prepared by the switchboard operator and is kept current by operator(s) on duty. At division artillery level or above, the diagram is prepared by the wire chief and kept current by the operators. In units equipped with the switchboard cover, circuits will be tested and determined to be in operating condition before they are initially recorded on the traffic diagram.

10-48. PURPOSE

The traffic diagram is used as an aid to the switchboard operator in routing telephone calls through a wire system over the most direct route. A traffic diagram shows alternate routes that may be used if direct routes are busy or out of service.

10-49. SECURITY

Local security measures will determine the extent of information that will be placed on traffic diagrams.

10-50. CONSTRUCTING A TRAFFIC DIAGRAM

A switching central is indicated by the appropriate directory name enclosed within a large circle on the traffic diagram (fig 10-41). The unit designations may be shown by symbols when security will not be jeopardized. A telephone is represented by a small circle with the identifying abbreviated designation.

a. A trunk circuit is indicated by a single line drawn between the switching centrals.

b. A circuit is represented by a single line drawn between the appropriate symbols; e.g., a unit directory name enclosed within a large circle represents a switching central, and a small circle identified by the abbreviated designation represents a telephone.

c. The number of channels available is indicated by a number placed along the line between switching centrals. Simplex circuits and phantom circuits are included as channels only when the switchboard operator can control these circuits; e.g., when the phantom or simplex circuit is terminated in the switchboard through a C-161 unit and a line pack.

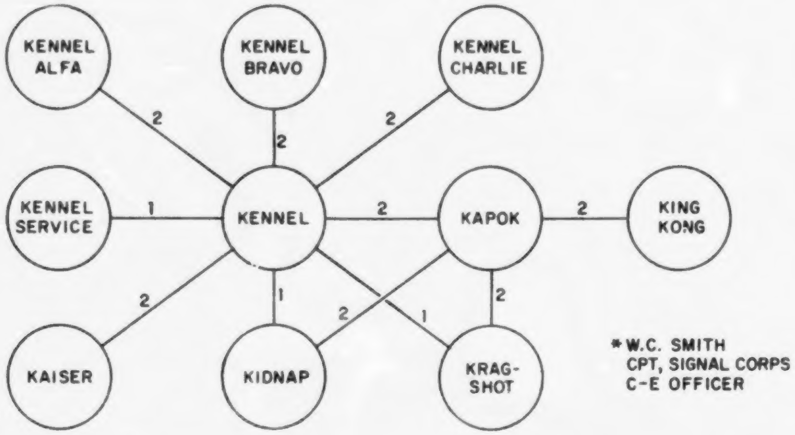
d. When possible, the connecting systems of higher, lower, and adjacent units should be included in the diagram.

e. Marginal information is not included in a traffic diagram. However, if a copy of the traffic diagram is to be forwarded to higher headquarters, the copy forwarded should include the following marginal information.

(1) What is it? Telephone traffic diagram.

(2) Who submitted? Designation of the originating unit.

TELEPHONE TRAFFIC DIAGRAM 2D BN, 45th FA
EFFECTIVE 281800 May 1976


KENNEL ALFA
KENNEL BRAVO
KENNEL CHARLIE
KENNEL SERVICE
KENNEL
KAPOK
KING KONG
KAISER
KIDNAP
KRAG-SHOT
2
2
2
1
2
2
2
1
2
1
2
*W.C. SMITH
CPT, SIGNAL CORPS
C-E OFFICER

*Authenticated when required by local order or when diagram is used as a report to higher headquarters.

Figure 10-41. Telephone traffic diagram.

(3) When submitted? The date and time of preparation.

(4) Authentication? The communications-electronics officer or his authorized representative must sign the traffic diagram before it is forwarded.

f. Figure 4 represents a traffic diagram prepared by the 2d Bn, 45th FA, to be forwarded to higher headquarters.

Section IX. LINE ROUTE MAP

10-51. DEFINIATION

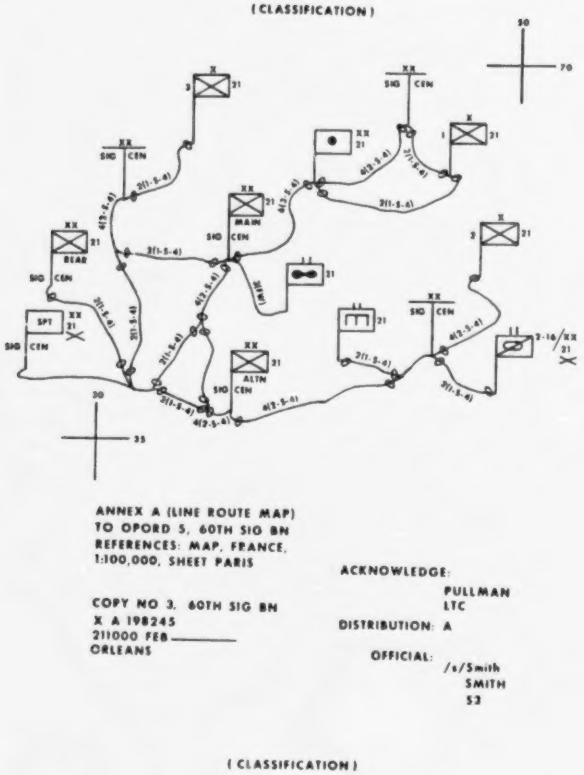
A line route map is a map, substitute, or overlay, suitably titled, on which the actual or projected routes of wire circuits are shown. The line route map does not show the actual connection at the switching central.

10-52. USES

The principal uses of the line route map are to report the physical location of wire circuits actually installed on the ground, to direct the installation of the wire, and to turn wire circuits over to a relieving unit.

10-53. PREPARATION

The battalion communications-electronics staff officer is responsible for the construction, use, and safeguarding of the battalion line route map. The line route map is prepared in duplicate. It is normally prepared by the wire chief and checked by the communication chief.



ANNEX A (LINE ROUTE MAP)
TO OPORD 5, 60TH SIG BN
REFERENCES: MAP, FRANCE,
1:100,000, SHEET PARIS

ACKNOWLEDGE:
PULLMAN
LTC

COPY NO 3, 60TH SIG BN
X A 198245
211000 FEB ______
ORLEANS

DISTRIBUTION: A

OFFICIAL:
/s/Smith
SMITH
S3

(CLASSIFICATION)

*Authenticated when required by local order or when map is used as a report to higher headquarters.

Figure 10-42. Line route map overlay.

10-54. DISPOSITION

One copy of the line route map is sent to the next higher headquarters; the other copy is posted in the vicinity of the switchboard of the orginating headquarters.

10-55. CONSTRUCTION

The line route map should contain only those lines, symbols, and notations necessary for clarity. Each headquarters or establishment served by the wire system is shown by the authorized military symbol. Switching centrals, which are part of the wire system, will be shown by the authorized military symbol. A telephone is represented by a small circle. Each trunkline or long local is represented by a single line drawn along the exact route over which the circuit is installed. The number of physical circuits installed along a particular route is indicated by a number placed next to the line. Simplex phantom circuits are not shown on the line route map. Field wire circuits indicated on the line route map are laid on the ground unless otherwise indicated. Each overhead circuit (///////) or underground circuit (UUUUUUU) will be shown by its appropriate symbol.

Line route maps prepared on overlay paper must each include at least two orientation points taken from the map which the overlay was made. The following information will be placed on the line route map wherever space is available.

a. What is it? Line route map?

b. Who prepared it? The designation of the unit preparing the line route map.

c. When was it prepared? The date and time of preparation.

d. In what area is it located? Title of the map. (Sheet name, scale and scale name.)

e. Authentication? Normally authenticated by the unit communications-electronics officer.

10-56. SECURITY

Line route maps are usually classified, since they indicate unit locations. They will not normally be taken into forward areas. Maintenance crews will carry only the extracts that pertain to their particular mission. Such extracts will not include unit designations.

10-57. TYPICAL LINE ROUTE MAP

Figure 10-42 shows a typical line route map prepared by the 2d Bn, 45th FA.

Section X. WIRE TAGGING

10-58. IMPORTANCE OF TAGGING

The proper tagging of field lines is considered a very important part of good line construction. This will often be the only method available to identify the unit's lines. The identification will greatly assist the wireman in tracing trouble on the line. One of the greatest problems the wireman has is identifying his own line when it is laid along the same route with several others. Without proper tagging, the wireman must tape the line and call the switchboard until he finds his oun line. Proper tagging eliminates the need for this. If the tags normally issued are not available, each unit is expected to improvise a suitable substitute. Each unit is responsible for insuring that its lines are properly tagged.

10-59. POINTS TO BE TAGGED

During wire laying, lines are tagged and tied at the following points:

a. At all crossings of roads, trails, railroads, bridges, etc., whether the wire is buried or installed overhead.

b. At all telephones, switchboards, repeater stations, and test stations.

c. Where wire installation changes from surface to underground or from surface to over-head.

d. Where a line branches off the main route.

e. At frequent intervals where several lines are laid along the same route.

f. At possible trouble spots along a route.

10-60. MARKING OF TAGS

Tags will be cut, notched, colored, or otherwise marked in accordance with the GEOICESI of the unit concerned. These markings must not disclose the identify of the unit.

10-61. RECOVERY OF FIELD WIRE

Field wire is recovered for reuse whenever possible. This is important as an economy measure, because recovered field wire constitutes a source of wire supply. Wire should be recovered as soon as it is no longer required. The wire should be repaired, tested, and placed in serviceable condition for future use.

Notes. ____

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Section XI. TERMINAL STRIPS AND REPEATING COILS

10-62. TELEPHONE REPEATING COILS

General. Additional circuits can be obtained from existing metallic circuits by the use of repeating coils. These additional circuits are called simplex and phantom circuits. Two repeating coils are required to install a simplex circuit, and four repeating coils are required to install a phamtom circuit.

a. Telephone repeating coil G-161 (fig 10-43) is a single repeating coil housed in a metal case. Screw-type binding posts are provided for the necessary wire connections.

b. Telephone repeating coil assembly TA-145/GT (fig 10-44) is a lightweight, weatherproof metal box containing four permanently installed repeating coils. Push-type binding posts are provided for the necessary wire connections.

10-63. TERMINAL BOX TA-125/GT

Terminal Box TA-125/GT (fig 10-42) is a small lightweight piece of equipment. It is used as a signal center and test points and test points where weatherproof terminations are essential for uninterrupted service. The terminal box is used wherever rapid installation of field wire or cable circuits is required. It also may be used as a main distributing frame for Switchboards SB-22/PT and SB-86/P.

10-64. TERMINAL STRIP TM-184

Terminal Strip TM-184 (fig 10-42) is a block of insulating material, on which are mounted 28 insulation-piercing binding posts and 4 mounting holes. This terminal strip can terminate seven pairs of wires.

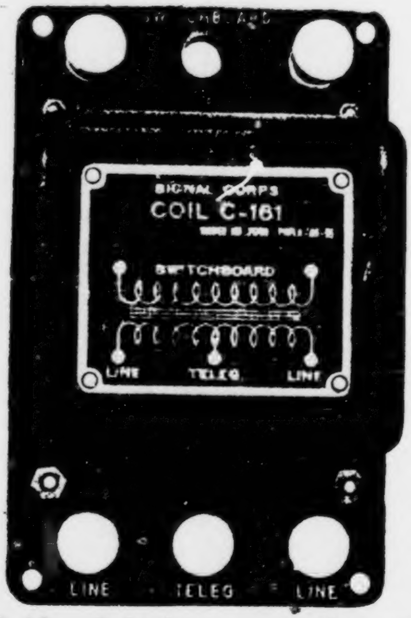


Figure 10-43. Telephone repeating coil C-161.

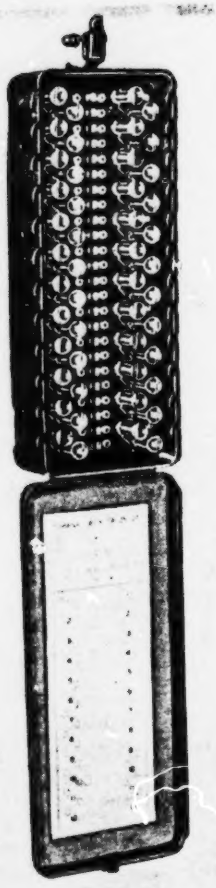
Section XII. SIMPLEX AND PHANTOM CIRCUITS

10-65. SIMPLEX CIRCUITS

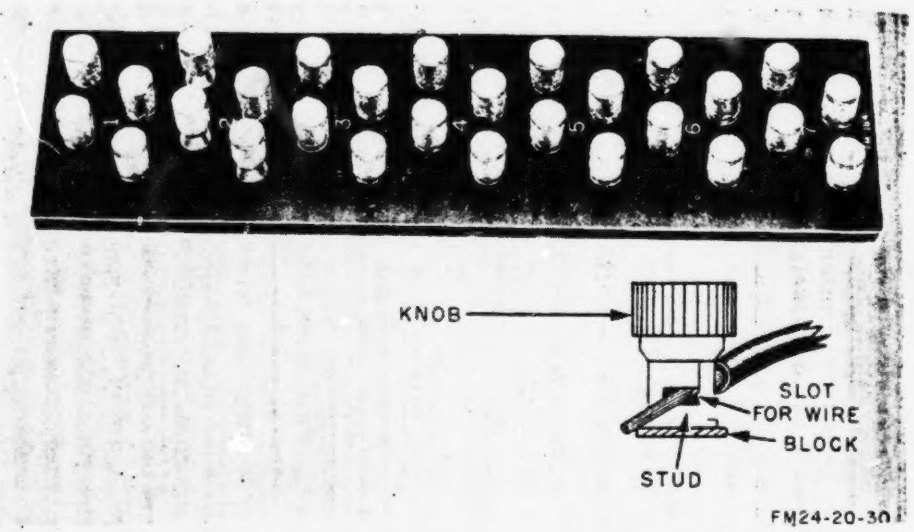
A simplex circuit may be defined as a ground-return circuit superimposed on a metallic circuit by the use of two repeating coils. A good ground is neceessary for satisfactory operation of ground-return circuits. Good connections may be improved by driving the ground stakes in damp soil, by using several ground stakes in series, by wetting the soil around the ground stakes, or by driving the ground stake near roots of vegetation. A telephone should be grounded near the telephone repeating coil assembly so that the instrument can be moved about freely.

10-66. PHANTOM CIRCUITS

A phantom circuit is an additional channel of communication superimposed upon two existing metallic circuits by means of four repeating coils. Metallic wire circuits must be balanced (of equal length and equal resistance) because imbalance will result in crosstalk between the phantom channel and the side circuits. The phantom circuit may be used for a teletypewriter channel when a good ground connection is difficult to obtain. The phantom circuit may be used to provide an additional channel between two command posts without mutual interference. The phantom channel may or may not be controlled by the switchboard operator. The operator can supervise a phantom channel by using a spare telephone.



FM24-20-170



FM24-20-30

TERMINAL STRIP TM-184

Figure 10-44. Telephone repeating coil assembly TA-145/GT, terminal box TA-125/GT, and terminal strip TM-184.

CHAPTER 11

FIELD TELETYPEWRITER EQUIPMENT

Section I. INTRODUCTION

11-1. GENERAL

Teletypewriter communication is one of the most widely used methods of communication in the Army. It has many advantages over other methods of communication. Transmitting speed normally is 60 words per minute, and circuits permitting transmission of 100 words per minute, and circuits permitting are not unusual. Messages are received in page or tape of form to facilitate handling and filing.

11-2. TELETYPEWRITER SYSTEMS

a. Teletypewriter communication is a method of transmitting and receiving signals by means of electrical impulses. Intelligence is conveyed from a sending station to one or more receiving stations by means of a signal code over direct current systems, over carrier systems, or over radio channels.

b. In the DC system, current flow is interrupted or reversed in polarity by the transmitting station. This system is used extensively over short field wire circuits.

c. In a carrier system, the transmitting teletypewriter sends DC impulses to local carrier equipment that converts these signals to frequencies of alternating current and transmits the signals as frequencies to the signal line. At the receiving station, the signals are received as two frequencies, converted to DC impulses, and transmitted to the receiving teletypewriter.

d. Radioteletypewriter communication is the most commonly used system. It combines the use of transmitters and receivers with teletypewriter equipment.

Section II. TELETYPEWRITER SET AN/UGC-4

11-3. DESCRIPTION

Teletypewriter set AN/UGC-4 (fig 11-1) includes a page painter, a keyboard transmitter, and a power supply. The page printer provides a written copy of each message transmitted or received.

11-4. CHARACTERISTICS

a. Weight. The AN/UGC-4, including the power supply and a roll of paper, weighs approximately 70 pounds.

b. Keyboard. The AN/UGC-4 has a standard communications keyboard.

c. Characters per line. The AN/UGC-4 will print 72 characters per line. The margin signal bell should ring when the 66th character has been printed.

d. Operating speeds. This set is shipped by the manufacturer with the 60-words-per-minute gears installed and the 100-words-per-minute gears supplied as accessory equipment. If operation at 66 words per minute or 75 words per minute is desired, the proper gears must be obtained through normal supply channels.

PHOTO NOT AVAILABLE

Figure 11-1. Teletypewriter set AN/UGC-4.

e. Operations per minute. Speeds expressed in operations per minute are stamped on the sides of the main shaft-driven gears and on the cylindrical portions of the worm gears. The speeds expressed as operations per minute (368, 404, 460, and 600) correspond to the speeds expressed as words per minute (60, 66, 75, and 100 respectively).

f. Paper capacity. The teletypewriter set is adjustable to accommodate standard one-through six-copy roll or fanfold paper or sprocket-fed forms, 8 1/2 inches wide.

g. Paper feed. Paper is fed by friction or sprocket. Friction is applied by means of a pressure roller lever. Fanfold paper and sprocket-fed forms are fed by extended sprocket feed pins on each side of the platen.

h. Signaling code. The standard five-unit start-stop code is transmitted and received. (Fig 11-10.)

i. Line current. The line current is 60 milliamperes for the DC system and 20 miliamperes for voice-frequency operation.

j. Power source. This set operates from a power source of 115 volts or 230 volts AC, 50 to 60 hertz.

k. Motor voltage. The teletypewriter motor operates from a power source of 115 volts AC, 50 to 60 hertz.

l. Motor speed. The governor assembly on the motor is adjustable to permit the motor speed to be maintained at precisely 3,600 revolutions per minute.

m. Power supply output. The power supply, located at the rear of the teletypewriter, is a plug-in full-wave rectifier that provides a source of DC for the line current. Plug-in taps permit adjustament so that the output is 120 volts DC.

n. Pertinent publication. TM 11-5815-200-12.

Section III. TELETYPEWRITER SET AN/GGC-3

11-5. DESCRIPTION

Teletypewriter set AN/GGC-3 (fig 11-2) provides for manual transmission direct from the keyboard and for tape transmission from the transmitter-distributor. Received messages are printed on a paper tape.

11-6. CHARACTERISTICS

a. Weight. The AN/GGC-3 with the case and a full roll of paper tape weighs approximately 100 pounds.

b. Keyboard. The AN/GGC-3 has a standard communication keyboard.

c. Charactrs per line. The character counter records a maximum of 76 characters. The margin signal bell should ring and the end-of-line indicator lamp should light when the 66th character is printed. Unlike the AN/UGC-4, the AN/GGC-3 has no automatic line feed and carriage return. After typing the 66th character, the operator should press the carriage return key. This will cause the character counter to return to 0 and the carriage on the page printer to return to the left margin.

d. Operating speeds. The operating speeds of the AN/GGC-3 are the same as those of the AN/UGC-4 (60, 66, 75, or 100 words per minute).

e. Operations per minute. The speeds expressed as operations per minute (368, 404, 460, and 600) correspond to the speeds expressed as words per minute (60, 66, 75 and 100, respectively).

f. Tape capacity. A full is fed through the machine by means of a sprocket.

g. Tape feed. Tape is fed through the machine by means of a sprocket.

h. Signaling code. The standard five-unit start-stop code is transmitted and received.

i. Line current. Line current requirements are the same as those for the AN/UGC-4-- 60 milliamperes for the DC system and 20 milliamperes for voice-frquency operation. The AN/GGC-3 provides direct current for operaion of the internal local circuits only. Line current must be supplied from some external source, such as telegraph terminal TH-5/TG or another teletypewriter set.

j. Power source. The AN/GGC-3 operates from a power source of 115 or 230 volts AC, 50 to 60 hertz.

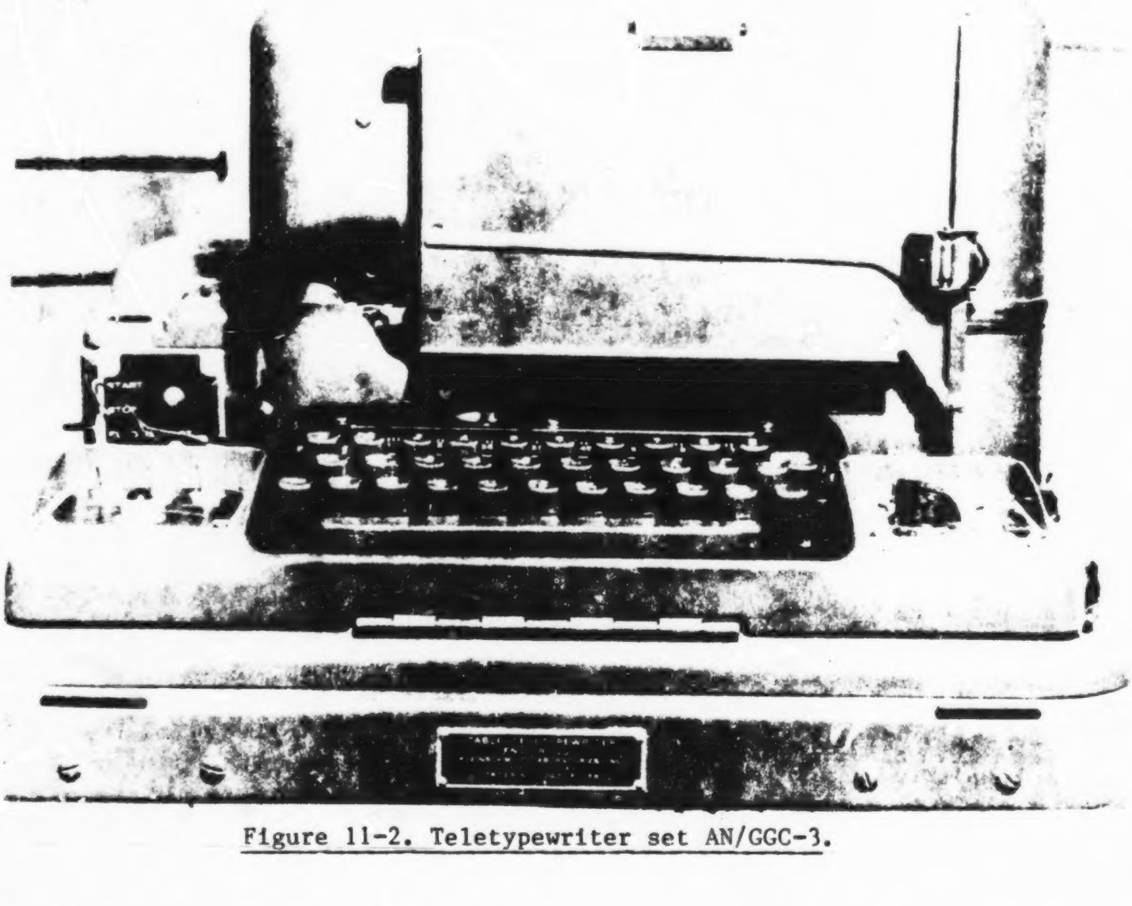


Figure 11-2. Teletypewriter set AN/GGC-3.

k. Motor voltage. The motor operates from a power source of 115 volts AC, 50 to 60 hertz.

l. Motor speed. The motor speed is governed to 3,600 revolutions per minute.

m. Pertinent publications. TM 11-5815-238-12.

Section IV. TELEGRAPH-TELEPHONE TERMINAL AN/TCC-14

11-7. DESCRIPTION AND USE

a. General. Telegraph-telephone terminal AN/TCC-14 is a terminal for teletypewriter and telephone equipment and provides for simultaneous transmission of speech signals with voice-frequency teletype and ringing signals.

b. Components. The AN/TCC-14 is a combination of three separate components-telegraph terminal TH-5/TG (fig 11-3), telegraph-telephone signal converter TA-182/U (fig 11-4), and electrical filter assembly F-98/U (fig 11-5).

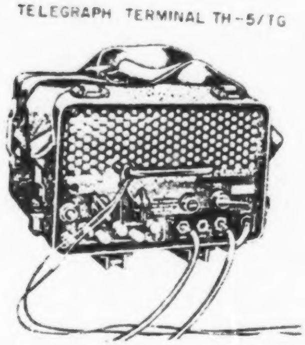


Figure 11-3. Telegraph terminal TH-5/TG.

(1) Telegraph terminal TH-5/TG is a frequency-shift-carrier modulator and demodulator. It modulates teletypewriter DC pulses to 1225-and 1325-hertz frequencies. It demodulates 1225-and 1325-hertz frequencies to teletypewriter DC pulses. The front panel contains two three-position wafer-type switches used to select the type of operation. A nonlocking lever switch is used to transmit a 20-hertz signal. Three teletypewriter jacks are provided for teletypewriter connections. There are six binding posts for connection in two-wire, four-wire, and radioteletypewriter applications.

(2) Telegraph-telephone signal converter TA-182/U provides a means of signaling in circuits that will not pass 20-hertz ringing signals because of line or equipment characteristics. The converter midulates 20-hertz frequencies to 1225-hertz frequencies for teletypewriter signaling or to 1600-hertz frequencies for telephone signaling. It demodulates 1225-hertz and 1600-hertz frequencies to 20-hertz frequencies for signaling the telephone equipment. On the front panel are two two-position wafer-type switches that are used to select the specific type of operation. Eight binding posts are used for line and loop connections.

(3) Electrical filter assembly F-98/U is a two-section filter. The band-pass section is used for teletypewriter transmission; the band-stop section is used for telephone transmission. Use of the F-98/U permits simultaneous teletypewriter and telephone service. The six binding posts on the face of the front panel are for interconnection with associated equipment and the line.

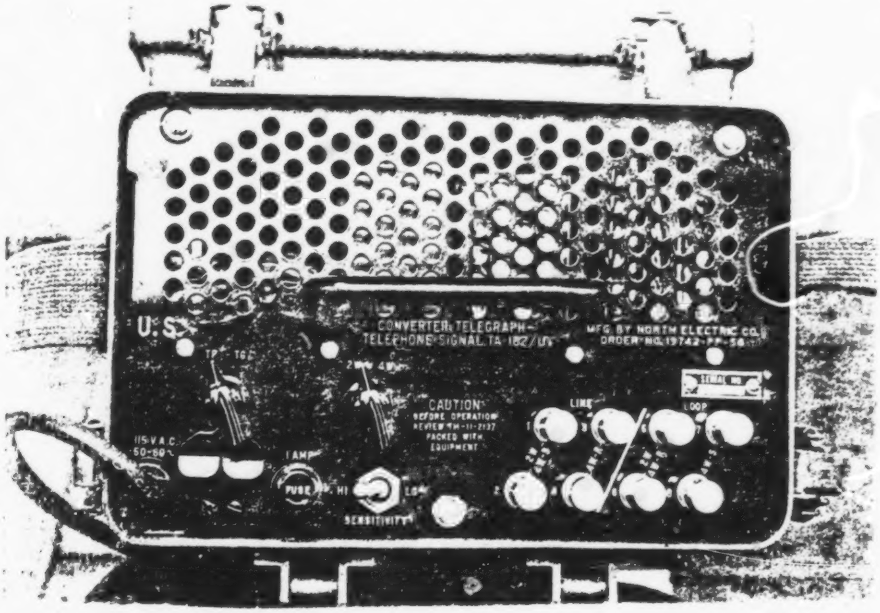

U.S.
CONVERTER, TELEGRAPH-TELEPHONE SIGNAL TA-182/U
MFG. BY NORTH ELECTRIC CO.
CAUTION
BEFORE OPERATION REVIEW TM-11-2137 PACKED WITH EQUIPMENT
LINE
LOOP
115 V.A.C. 50-60~
LAMP
FUSE
SENSITIVITY

Figure 11-4. Telegraph-telephone signal converter TA-182/U.

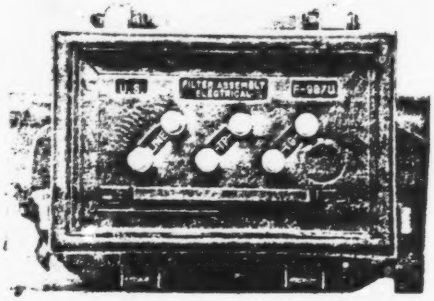

U.S.
FILTER ASSEMBLY ELECTRICAL
F-98/U

Figure 11-5. Electrical filter assembly F-98/U.

11-8. CHARACTERISTICS

a. Telegraph terminal TH-5/TG.

(1) Circuit application. Used in either a two-wire or four-wire system.

(2) Type of modulation. Each mark impulse is 1325 hertz. Each space impulse is 1225 hertz.

(3) Transmission speeds. May be used with teletypewriter at speeds of 60, 75, or 100 per minute.

(4) Voltage requirement. 115 volts AC, 50 to 60 hertz.

b. Signal converter TA-182/U.

(1) Circuit application. Used in either a two-wire or a four-wire system.

(2) Signaling frequencies. The line signals are 1225 hertz for teletype signals and 1600 hertz for telephone signals. The loop signals are 20 hertz.

(3) Voltage requirement. 115 volts AC, 50 to 60 hertz.

c. Filter assembly F-98/U.

(1) Circuit application. Used in a two-wire system.

(2) Voltage requirement. No power is required.

d. Pertinent publication. TM 11-5805-254-15.

11-9. SYSTEM APPLICATION

a. The teletypewriter normally is connected to the TH-5/TG. Use of the TA-182/U as shown in figure 11-6 will provide a half-duplex voice-frequency circuit over field wire or an area system with a signaling capability. If the circuit will pass the 20 hertz signal, the TA-182/U is not needed.

b. If a second circuit is needed for telephone service, another TA-182/U is required. This provides a half-duplex voice-frequency teletypewriter circuit plus a full-duplex telephone circuit with a signaling capability.

c. If only one circuit is available, two TA-182/U's and the electrical filter assembly F-98U can be used to provide a half-duplex voice-frequency teletypewriter capability over a single voice-frequency circuit.

Section V. TELEGRAPH-TELEPHONE TERMINAL AN/TCC-29

11.10. DESCRIPTION AND USE

a. General. Telegraph-telephone terminal AN/TCC-29 is a terminal for teletypewriter and telephone equipment and provides for simultaneous transmission of speech signals with voice-frequency teletype and ringing signals. The AN/TCC-29 is lightweight and completely transistorized. It is replacing the AN/TCC-14 on an attrition basis.

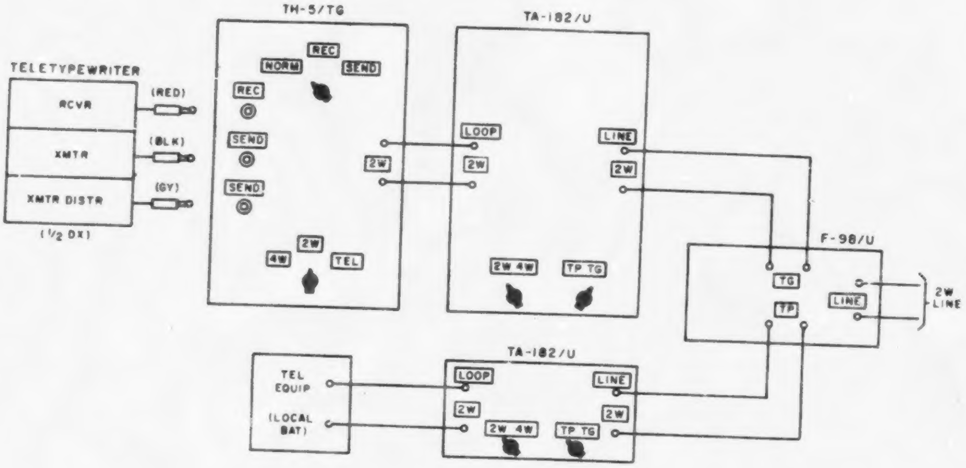

TH-5/TG
TA-182/U
TELETYPEWRITER
RCVR
XMTR
XMTR DISTR
(1/2 DX)
(RED)
(BLK)
(GY)
NORM
REC
SEND
REC
SEND
SEND
2W
4W
2W
TEL
LOOP
2W
LINE
2W
2W 4W
TP TG
F-98/U
TG
TP
LINE
2W LINE
TA-182/U
TEL EQUIP
(LOCAL BAT)
LOOP
LINE
2W
2W
2W 4W
TP TG

Figure 11-6. Typical application of telegraph-telephone AN/TCC-14.

b. Components. The AN/TCC-29 consists of three self-contained units-telegraph terminal TH-22/TG (fig 11-7), telegraph-telephone signal converter CV-425/U (fig 11-8), and electrical filter assembly F-316/U (fig 11-9).

(1) TH-22/TG. Telegraph terminal TH-22/TG is a lightweight, transistorized, frequency-shift-keying device. It modulates DC teletypewriter pulses to 1232.5-hertz frequencies to DC teletypewriter pulses.

(2) CV-425/U. Telegraph-telephone signal converter CV-425/U provides a means of signaling in circuits that will not pass 20-hertz ringing signals because of line or equipment characteristics. The CV-425/U converts 20-hertz ringing signals to 1232. 5-hertz signals for teletypewriter signaling or to 1600-hertz for telephone signaling.

(3) F-316/U. Electrical filter assembly F-316/U is a two-section filter. It provides a means for simultaneous transmission or reception of teletypewriter and speech signals.

Notes.

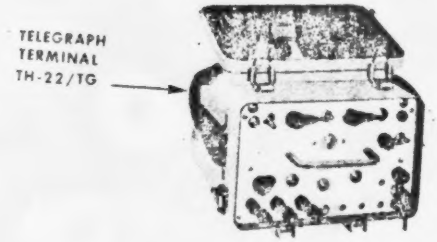

TELEGRAPH
TERMINAL
TH-22/TG

Figure 11-7. Telegraph terminal TH-22/TG.

Notes.

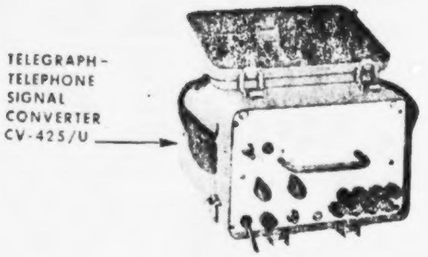

TELEGRAPH-
TELEPHONE
SIGNAL
CONVERTER
CV-425/U

Figure 11-8. Telegraph-telephone signal converter CV-425/U.

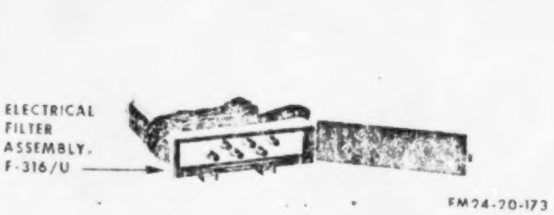

ELECTRICAL
FILTER
ASSEMBLY,
F-316/U
FM24-20-173

Figure 11-9. Electrical filter assembly F-316/U.

11-11. CHARACTERISTICS

a. Telegraph terminal TH-22/TG.

(1) Power requirements:

(a) 115 or 230 volts AC, 50 to 60 hertz.

(b) 26 volts DC ±4.

(2) Power drain:

(a) 20 watts AC.

(b) 24 watts DC.

(3) Operational modes:

(a) Mode 1: 60, 75, or 100 words per minute.

(b) Mode 2: 200 words per minute.

(4) Type of modulation: Frequency shift.

(5) Bandwidth: 1200 to 1400 hertz.

(6) Mark frquency: 1317.5 hertz ±3.

(7) Space frequency 1232.5 hertz ±3.

b. Signal converter CV-425/U.

(1) Power requirements: 115 or 230 volts AC, 50 to 60 hertz.

(2) Power drain: 25 watts.

(3) Low-frequency signal input: 20 hertz.

(4) Teletypewriter signaling frequency: 1232.5 hertz.

(5) Telephone signaling frequency: 1600 hertz.

c. F-316/U.

(1) Power requirements: None.

(2) Midfrequency: 1275 hertz.

d. Pertinent publication. TM 11-5805-356-12.

SupR
80170

11-12. SYSTEM APPLICATION

The telegraph-telephone terminal AN/TCC-29 is installed in the same manner as the AN-TCC-14 to perform the same functions (fig 11-6). Terminal components may be installed as a group or individual components may be exchanged, item for like item, for components of the AN/TCC-14.

CHAPTER 12

RADIOTELEPHONE PROCEDURE

12-1. PRINCIPLES OF RADIO NET OPERATION.

a. Radio net. A radio net consists of two or more radio stations working together on the same frequency normally for the same purpose.

b. Basic requirements. The principles of radio net operation are designed to standardize and control the operating practices of communication personnel so that the basic communication requirements of reliability, security, and speed can be met. Reliability, security, and speed decrease in direct proportion to each incorrect transmission.

c. Communication descipline. Radio operators must always use prescribed radio procedure. Radio communication will be improved if operators will observe the following rules:

(1) Make only authorized transmissions. Avoid unnecessary calling, testing and readability reports. Say only what has to be said!

(2) Listen before transmitting. Failure to listen before transmit- ting causes confusion and loss of time and necessitates additional transmissions.

(3) Answer promply. All transmission requiring an answer should be answered promptly. If unable to accept traffic, answer the call with the proword WAIT, coupled with the ending sign OUT.

(4) Transmit slowly. Transmit at a speed at which the slowest operator in the net can copy.

(5) Send clearly. Jerky transmissions or clipped speech are difficult to unserstand. Use standard phraseology.

(6) Use the phonetic alphabet. When communicating by radio, use the phonetic alphabet to transmit code groups and individual letters of the alphabet to transmit code groups and individual letters of the alphabet or to spell difficult or unfamiliar words.

12-2. NET CONTROL.

a. Net control station. The net control station (NCS) is the station in a radio net which controls and directs the operation of the net. The station serving the senior commander normally is designated as the NCS.

b. Function. The NCS's responsibilities include the supervision of the flow of traffic and maintenance of circuit discipline within the net.

c. Authority. The NCS has complete technical control over the operation of the net; it has no tactical control over the local administration of individual stations in the net. Within the scope of its authority, however, the decisions of the NCS are final.
d. Alternate NCS. An alternate NCS should be appointed prior to opera- tion. It takes charge of the net when the regular NCS is inoperative. When in control of the net, the alternate NCS assumes al the responsibilities and authority of the regular NCS. The station serving the next senior commander is normally designated the alternate NCS.

e. Operation. Radio nets operate as free or directed nets. In either type of net, secondary stations are required to report to the NCS prior to leaving the net, if possible.

(1) Free net. When operating conditions permit, the NCS authorizes secondary stations to operate as a free net. In this type of net, secondary stations may transmit to other stations in the net without first obtaining permission from the NCS.

(2) Directed net. When direct control of each transmission is advisable or necessary, the NCS orders that the net operate as a directed net, wherein, permission from the NCS must be obtained before secondary stations may transmit to other stations in the net. Normally, direct nets are necessary when complicated traffic patterns exist or when security warrants direct control of each transmission by a control station.

12-3. RADIOTELEPHONE PROCEDURE. Radiotelephone procedure includes the use of call signs and the use of procedure words in every transmission.

a. Call signs. Call signs are used for station identification and are always included in the beginning (heading) of a transmission. A radio station is always referred to by its call sign, never in clear text by unit designation, name of commander, or name of operator. A complete call sign consists of a letter-number-letter and a suffix. The call sign (letter-number-letter) represents the net. For example, A5X represents 1st Battalion, 34th Infantry, 5th Infantry Division. The suffix distinguishes stations in the net. For example, A5X represents 1st Battalion, 34th Infantry, 5th Infantry Division. The suffix distinguishes stations in the net. For example, 26 represents NCS. The complete call sign A5X26 represents NCS for the 1-34th Infantry Battalion, 5th Infantry Division. Call signs, suffixes, and frequencies change daily.

b. Procedure words. Procedure words (prowords) are desinged primarily to expediate the handling of messages. However, they must never be used as a substitute for the text of a message (para 13).

12-4. MESSAGE FORMAT. Each message transmitted by radio is divided into three principal parts-the heading, the text, and the ending. Each part may be divided into several elements. Each message contains only those elements essential to the transmission of that particular message.

a. Heading. The heading may include any or all of the elements below which, when included, are transmitted in the order shown. The separative sign (-) is used in this instructional note to facilitate recognition of different elements.

(1) Call signs. . . . . D6R20 THIS IS T3B02

(2) Warning to copy . . . . MESSAGE

(3) Transmission instructions . . RELAY -

(4) Precedence. . . . . PRIORITY -

(5) Date-time group . . . . TIME 161900S JUL 75 -

(6) Address instructions. . . . . D6R05 TO C8S2 1

(7) Separation of text from other portions of message . . BREAK (used between heading and text and text and ending

b. Text. The text expresses the basic idea of the orginator.

c. Ending.

(1) Final instructions, such as corrections or an indication of additional messages, may be included in the ending.

(a) Corrections . . . . CORRECTION - WORD AFTER FLD - FRP

(b) Additional message. . . . . . . MORE TO FOLLOW

(2) Every transmission ends either with OVER or OUT. OVER may be omitted in a two-station net.

(a) Answer required. . . . . OVER

(b) No answer required . . . . OUT

12-5. ILLUSTRATIONS OF PROCEDURE. The illustrations below show the principles of radio net operation, the types of calls and how they are answered, and the methods used by the NCS to maintain circuit discipline. The principal parts of a message and some of the more common elements of each part are included.

a. Use of full call. A full call is used when establishing/reastablishing or closing communications and when radio reception is poor. Example:

A5X16 THIS IS G4T58 - OVER
G4T58 THIS IS A5X16 . . . .

b. Use of the net call. A net call is a transmission which is directed to all stations in a net. One of the functions of the NCS is to organize the net. (ANY station operating in the net may place a net call.) The following transmissions illustrate the organization (opening) of a radio net (stations are shown in figure 12-1). The opening is illustrated using authentication.

(1) The net NCS transmits -

J4T THIS IS J4T28 - AUTHENTICATE RQ - OVER

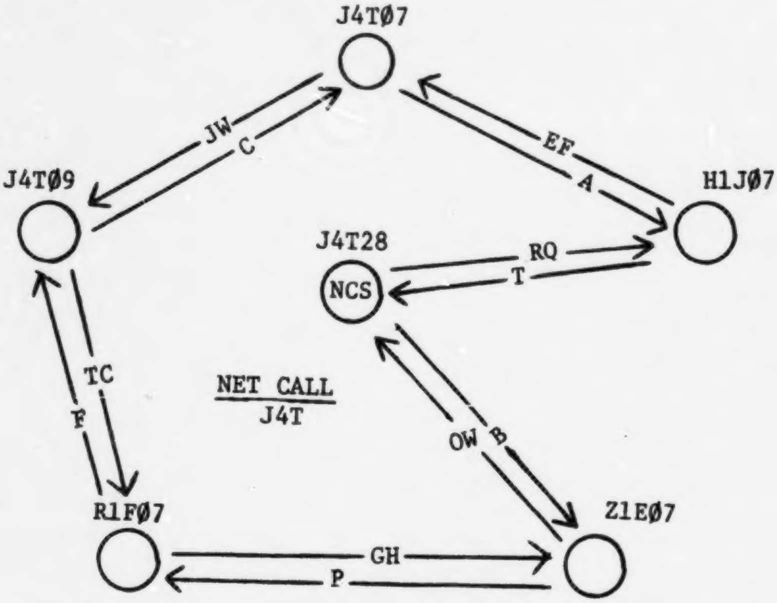


Figure 12-1. Radio net illustrating net opening.

(2) Subordinate stations answer a net call in alphanumeric order of call signs, addressing their call to the NCS as follows:

J4T28 THIS IS H1J07 - I AUTHENTICATE T, AUTHENTICATE EF - OVER
J4T28 THIS IS J4T07 - I AUTHENTICATE A, AUTHENTICATE JW - OVER
J4T28 THIS IS J4T09 - I AUTHENTICATE C, AUTHENTICATE TC - OVER
J4T28 THIS IS R1F07 - I AUTHENTICATE F, AUTHENTICATE GH - OVER
J4T28 THIS IS Z1E07 - I AUTHENTICATE P, AUTHENTICATE OW - OVER

J4T28, the NCS, noting that all stations have answered in proper order, authenticated properly, and that he has no traffic for them transmits -

J4T THIS IS J4T28 - I AUTHENTICATE B, THE NET IS NOW OPEN, THE TIME IS 11430Z JUL 75 - OUT

(3) If a station is unable to answer in the proper order, it must wait until all other stations have made their transmissions and then respond.

(a) J4T09 is unable to answer in proper order; R1F07 waits a reasonable length of time (5 or 6 seconds) and then makes his transmissions.

(b) All stations except J4T09 have now entered the net. J4T09 is now able to enter the net so he makes his transmission.

a J4T28 THIS IS J4T09 I AM PREPARED TO AUTHENTICATE - OVER
J4T09 THIS IS J4T28 AUTHENTICATE EW - OVER
J4T28 THIS IS J4T09 I AUTHENTICATE S - OVER

(c) With all stations now in the net, J4T28 transmits -

J4T THIS IS J4T28 - OUT

(4) If a station does not answer in proper order nor after all other stations, the following procedure is used:

J4T09 DID NOT ANSWER THE NET CALL.

(a) The NCS does not keep the stations who have entered the net waiting but transmit -

J4T THIS IS J4T28 - ROGER -
J4T09 - NOTHING HEARD - OUT.

(b) Net control then transmits -

J4T09 THIS IS J4T28 - OVER

(c) J4T09, hearing the call of the NCS, answers -

J4T28 THIS IS J4T09 - OVER

(d) Net control answers and requests exchange of authentication.

(5) Secondary stations should answer in the proper order; answering out of turn is cause for the NCS to take corrective action.

NOTE: Once the net has been established, an abbreviated call and/or call sign may be used once full call signs have been exchanged between stations desiring to communicate with each other. An abbreviated call is where the calling station gives his call sign but not the call sign of the called station (Example: A5X16 has traffic for G6P37 where each station exchanged full calls. Continuing their communications, both stations may use the abbreviated call (This is A5X16 or This is G6P37) without using the other's call sign. An abbreviated call sign may be used in the above example also. (Example: P37 this is X16 or merely this is X16.)

When abbreviated call signs are used the sequence of answering is the same as if full call signs were in use. Various examples of the abbreviated call follow:

PRELIMINARY CALL

H1J07 THIS IS J4T09 - OVER
J4T09 THIS IS H1J07 - OVER

ABBREVIATED CALLS

J07 THIS IS T09 - MESSAGE - or THIS IS T09 - MESSAGE -
or THIS IS J4T09 - MESSAGE -

c. Use of the collective call. A collective call is one which is directed to several stations in the radio net by using a predetermined collective call sign.

(1) Assume that A5X16 and F6C50 are called mor frequently than other stations in a net; in this event, these two stations could be assigned a collective call sign; for example, G4T66.

G4T66 THIS IS G4T58 - OVER

(2) Stations answer a collective call in alphabetical order of call signs. If the call words are the same, stations answer in numerical order of suffix numbers since the numbers are an extension of the alphabet. The preceding collective call in (1) above would be answered as follows:

G4T58 THIS IS A5X16 - OVER
G4T58 THIS IS F6C50 - OVER

d. Use of the multiple call. A multiple call is one which is directed to two or more stations in a radio net by using the call sign of each individual station.

(1) Assume that the NCS wants to contact A5X16 and F6C50. It would transmit -

A5X16, F6C50 THIS IS G4T28 - OVER

(2) Stations answer a multiple call in the order in which they are called.

G4T28 THIS IS A5X16 - OVER
G4T28 THIS IS F6C50 - OVER

12-6. USE OF PROCEDURE WORDS. Procedure words are used only between operators; they must never be used as a substitute for the text of a message. Every transmission must include prowords. Even a simple call contains two, and the atransmission of a message involves the use of several prowords.

a. The following example illustrates how and where prowords are used in the transmission of a simple, abbreviated message:

X16 THIS IS T58 - REPORT TO POINT XRAY - OVER

b. The extent to which prowords are used depends on the type of message, the operating instructions, or other circumstances. See paragraph 13 for a list of the prowords discussed in this instructional note.

12-7. APPLICATION OF PROCEDURE WORDS TO MESSAGE HANDLING.

a. Assume that G4T58 has a message for F6C50. G4T58 makes the following transmission.

F6C50 THIS IS G4T58 - OVER

b. F6C50, hearing the call and being in a position to accept traffic, would respond by transmitting -

G4T58 THIS IS F6C50 - OVER

c. The preliminary call having been completed, G4T58 continous with the message by transmitting -

C50 THIS IS T58 - MESSAGE - PRIORITY -
TIME 191516S JUL 74 - GROUP COUNT 03 BREAK - ABN EFG HPQ -
BREAK - OVER

Element	Transmission	Meaning
The call	C50 THIS IS T58	Message address.
Warning to copy	MESSAGE	A message follows which requires recording.
Precedence	PRIORITY -	The message takes precedence over routine messages.
Date-time group Group Count	TIME 191516S JUL 74 03	Date and time expressed in digits and zone suffix.
Separation	BREAK	I hereby separate the text from other portions of the message.
Text of message	ABN EFG HPQ - (Each letter is pronunced phonetically.)	This is the basic thought or idea of the originator.
Separation	Break	I hereby separate the text from its ending.
Ending	OVER	This is the end of my transmission: a reply is necessary.

d. Assume the F6C50 received message 191516S JUL 74 without difficulty. Opeating conditions between the stations are good. F6C50 would respond by transmitting -

*THIS IS C50 - ROGER - OUT

ELEMENT	Transmission	Meaning
*The call (abbreviated)	THIS IS C50 -	My identify is C50.
Receipt	ROGER -	I received your message satisfactorily.
Ending	OUT	This is the end of my transmission; no reply is needed.

*An abbreviated call omits the call sign of the called station. It may be used after identities have been established between stations and when operating conditions are such that confusion cannot result.

12-8. NET CONTROL AND DISCIPLINE. The following examples show a net in operation and some of the typical corrective actions taken by an NCS to maintain control and discipline:

a. Station answering out of turn.

(1) The call.

A5X16, F6C50 THIS IS G4T28 - OVER

(2) Incorrect reply (one type of error).

G4T28 THIS IS F6C50 - OVER
G4T28 THIS IS A5X16 - OVER

(3) The NSC takes corrective action and transmits its message in the same transmission.

X16, C50 THIS IS T28 - C50 -
YOU ARE ANSWERING OUT OF TURN - MESSAGE - ROUTINE -
TIME 191520S JUL 74 - GROUP COUNT 04 BREAK - EGR HMS FOD PRA -
BREAK - OVER

(4) Breach of operation rules (J4T09 - OVER)

(5) Corrective action by the NCS.

J4T09 THIS IS - LISTEN
IN BEFORE TRANSMITTING - WAIT - OUT

(6) Obtaining receipt (if addressees fail to comply as indicated in (7) below).

H1J07, A5X16 THIS IS J4T28 -
DID YOU RECEIVE MY MESSAGE TIME 191520S JUL 74 -
OVER

(7) Receipt using abbreviated call.

THIS IS J07 - ROGER - OUT
THIS IS X16 - ROGER - OUT

(8) Calling J4T09

J4T09 THIS IS J4T28 - SEND YOUR MESSAGE - OVER

(9) J4T09 answers.

J4T28 THIS IS J4T09 - NEGATIVE TRAFFIC - OUT

b. Station slow in answering.

(1) The call.

F6C50 THIS IS J4T28 - OVER

(No answer.)

F6C50 THIS IS J4T28 - OVER

(No answer.)

(2) Call signs twice.

F6C50, F6C50 THIS IS J4T28, J4T28 - OVER

(3) Incorrect reply. . . .

F6C50 TO J4T28 - GO AHEAD

(4) Corrective action by the NCS.

F6C50 THIS IS J4T28 - YOU ARE CAUSING DELAY BY YOUR SLOWNESS IN ANSWERING AND YOU ARE USING IMPROPER PROCEDURE - MESSAGE - ROUTINE - TIME 191529S JUL 74 - GROUP COUNT 02 BREAK - ELG - PRG - BREAK - OVER.

(5) Receipt for message.

THIS IS C50 - ROGER - OUT

c. Subordinate station leaves the net.

(1) The call.

J4T28 THIS IS A5X16 - REQUEST PERMISSION TO LEAVE THE NET FOR 10 MINUTES - OVER

(2) The NCS reply.

(THIS IS T28 - AFFIRMATIVE (or NEGATIVE) - OUT

NOTE: Subordinate stations are not required to ask permission to leave the net for tactical reasons but should state they are doing so if possible.

d. Appointing an alternate NCS.

(1) Net control station appointing its alternate.

C3W09 THIS IS G4T28 - STATION LEAVES NET TEMPORARILY -
YOU ARE NET CONTROL - OVER

(2) Receipt by alternate NCS.

THIS IS W09 - WILCO - OUT

e. Subordinate station reports into net.

(1) Station reports into net.

G4T28 THIS IS R1F07 - STATION REPORTS INTO NET - OVER

(2) Reply by alternate NCS.

R1F07 THIS IS C3W09 - I AM NET CONTROL STATION -
ROGER - OVER

f. Use of SILENCE and SILENCE LIFTED.

(1) When, for security reasons, it is necessary to deny the location of a radio station(s) from enemy intercept or direction finding stations, denial can be accomplished by transmitting the procedure word SILENCE three times.

(2) The NCS lifts emergency silence from the net by transmitting the procedure word SILENCE LIFTED.

(3) Authentication is mandatory when directing radio silence or when requiring a station to break an imposed radio silence.

g. Corrections during transmission.

(1) Assume that J4T28, while transmitting a message to A5X16, made an error in the second group of the text; the complete transmission would be -

A5X16 THIS IS J4T28 - MESSAGE - PRIORITY -
TIME 151513S JUL 74 - GROUP COUNT 04 BREAK - ABN ELG -
CORRECTION - ABN EFG HPQ QMK - BREAK - OVER

(2) When an error is made by the transmitting operator while in the process of transmitting, he immediately sends the proword CORRECTION, repeats the last group or word he transmitted correctly, corrects the group or word in error, and continues with this message.

h. Requests for repetition. A receiving operator who has missed or is not certain of a part or all of a message may request repetition by using the proword SAY AGAIN. The word "repeat" is not a proword and will never be used to request a repetition. The only time the word "repeat" is used in radiotelephone operation is when it appears as a word of the message text.

(1) Assume that A5X16 missed the entire message illustrated in g(1) above; he would transmit -

(2) In reponse to the request for repetition, J4T28 transmits -

X16 THIS IS T28 - I SAY AGAIN - A5X16 THIS IS J4T28 -
MESSAGE - PRIORITY - TIME 151513S JUL 74 - GORUP COUNT
04 - BREAK - ABN EFG HPQ QMK - BREAK - OVER

NOTE: In this instance the call serves as the message address and may be excluded from the repetition. If the request for repetition had been in response to a multiple address message (a(3) above), the response would include the message address as follows:

X16 THIS IS T28 - I SAY AGAIN - C50
X16 THIS IS T28 - MESSAGE - ROUTINE -
TIME 191520S JUL 74 - GROUP COUNT 04 BREAK -
EGR HMS FOD PRA - BREAK - OVER

(3) Receipt by A5X16.

THIS IS X16 - ROGER - OUT

(4) When requesting a repetition of a portion of a message, an operator will identify the portion he wants repeated by identifying adjacent groups or words or by group number if a group count is used.

(5) Assume that X16 missed only the portion of the message which followed EFG; he would request a repetition of that portion by transmitting -

T28 THIS IS X16 - SAY AGAIN ALL
AFTER EFG - OVER

(6) In response to this request, T28 transmits -

X16 THIS IS T28 - I SAY AGAIN ALL AFTER EFG -
HPQ QMK - OVER

(7) Assume that A5X16 - SAY AGAIN ALL BEFORE EFG - OVER

(8) In response to this request, T28 transmits -

X16 THIS IS T28 - I SAY AGAIN ALL BEFORE EFG-
MESSAGE - PRIORITY - TIME 151513S JUL 74 -
BREAK - ABN - OVER

(9) Assume that A5X16 missed the third group of the text of the message (HPQ); to request a repetition, he transmits -

T28 THIS IS X16 - SAY AGAIN WORD AFTER EFG - OVER

or

T28 THIS IS X16 - SAY AGAIN WORD BEFORE QMK - OVER

(10) In response, J4T28 - transmits -

X16 THIS IS T28 - I SAY AGAIN WORD AFTER
EFG - HPQ - OVER

or

X16 THIS IS T28, I SAY AGAIN WORD BEFORE
QMK - HPQ - OVER

(11) Assume that F6C50 missed that portion of the message between the word TIME and the group HPQ; repetition is requested by transmitting -

T28 THIS IS C50 - SAY AGAIN TIME TO HPQ - OVER

(12) In response to the request, T28 transmits -

C50 THIS IS T28 - I SAY AGAIN TIME TO HPQ -
TIME 151513S JUL 74 - BREAK - ABN EFG HPQ - OVER

12-9. CLASSIFIED MESSAGES TRANSMITTED IN CLEAR TEXT.

a. Messages classified SECRET or lower may be transmitted in the clear when authorized by a comander or his designated representative. Authorization must be given for each message to be transmitted in the clear.

b. Three conditions must exist simultaneously before authorization will be given to transmit a classified message in clear text. These conditions are as follows:

(1) Engaged in actual hostilities.

(2) Speed of delivery is so essential that time cannot be spared to encrypt the message.

(3) The information in the message cannot be acted upon by the enemy in time to influence current operations.

c. Classified messages are identified by the word CLEAR transmitted at the beginning of the text; this indicates to the receiving operator that the message contains classified information and must be handled at least as CONFIDENTIAL, and he must make the proper endorsement on the message form.

NOTE: Messages classified TOP SECRET will never be transmitted in clear text over an electrical circuit.

12-10. DIFFICULT OF UNFAMILIAR WORDS.

a. Difficult or unfamiliar words within the text of a plaintext message may be spelled by using the phonetic alphabet, preceded by the proword I SPELL. If the operator can pronounce the word to be spelled, he does so before and after the spelling to identify the word.

b. Assume that the radio operator at J4T28 has a message for A5X16 and the word EISENACH appears in the text of the message. If the radio operator can pronounce the word, he transmits the message as follows:

> X16 THIS IS T28 - MESSAGE - PRIORITY - TIME
> 151634S JUL 74 - BREAK - CLEAR - ROAD TO EISENACH -
> I SPELL - ECHO INDIA SIERRA ECHO NOVEMBER ALFA CHARLIE
> HOTEL - EISENACH - IS MINED - BREAK - OVER

c. If the radio operator at J4T28 could not pronounce the word, he would transmit the message as follows:

> X16 THIS IS T28 - MESSAGE - PRIORITY - TIME
> 151634S JUL 74 - BREAK - CLEAR - ROAD TO -
> I SPELL - ECHO INDIA SIERRA ECHO NOVEMBER ALFA
> CHARLIE HOTEL - IS MINED - BREAK - OVER

12-11. ACKNOWLEDGEMENTS.

a. Assume that J4T28 has an ACKNOWLEDGE message for A5X16. After making a prelimary call, J4T28 transmits -

> X16 THIS IS T28 - MESSAGE - PRIORITY - TIME
> 150955S JUL 74 - BREAK - CLEAR - MOVE TO ALTERNATE
> POSITION - BREAK - ACKNOWLEDGE - OVER

b. The addressee, represented by the call sign A5X16, is operating his own radio set; he acknowledges by transmitting -

> THIS IS X16 - WILCO - OUT

By use of the proword WILCO, the addressee has indicated that he has received the message, that he understands it, and that he is going to comply with it.

c. If the addressee is not operating his radio set or is not in close proximity to his set, his operator would transmit -

> THIS IS X16 - ROGER - OUT

d. When the addressee is ready to acknowledge, he acknowledges personally or informs the operator, who transmits -

J4T28 THIS IS A5X16 - YOUR MESSAGE
TIME 150955S JUL 74 ACKNOWLEDGED - OVER

e. J4T28, having received the acknowledgment of his message, transmits -

X16 THIS IS T28 - ROGER - OUT

12-12. SUMMARY.

a. The reliability, security, and speed of radio communication depend to a great extent on the strict adherence to proper procedure and circuit discipline by all operating personnel.

b. Every radio net has an NCS whose functions include supervision of the flow of traffic and maintenance of circuit discipline.

c. The format of radio-transmitted messages consists of three main parts: the heading, the text, and the ending.

d. Prowords are used to aid the radio operator. This instructional note does not include all of the prowords, but it does include those most commonly used. Prowords must be committed to memory and used verbatim. A complete understanding of the prowords and their meaning is essential for the expeditious handling of radio traffic.

12-13. LIST OF PROWORDS. The following is list of the prowords discussed in this instructional note. A complete list of prowords may be found in Allied Communication Publication (ACP) 125 (D).

Proword	Meaning
ALL AFTER	The portion of the message to which I have reference is all that which follows ____________________.
ALL BEFORE	The portion of the message to which I have reference is all that which precedes ____________________.
AUTHENTICATE	The station called is to reply to the challenge which follows:
AUTHINTICATION IS	The transmission authentication of this message is ____________________.
BREAK	I hereby indicate the separation of the text from other portions of the message. (In voice communciation, the proword BREAK is normally used between the heading and the text.)
CORRECT	You are correct, or what you have transmitted is correct.

Proword	Meaning
CORRECTION	An error has been made in this transmission Transmission will continue with the last word correctly transmitted. An error has been made in this transmission (or message indicated). The corrected version is ________________. That which follows is a corrected version in answer to your request for verification.
DISREGARD THIS TRANSMISSION	This transmission is in error. Disegard it. This proword shall not be used to cancel any message that has been completely transmitted and for which receipt or acknowledgment has been received.
DO NOT ANSWER	Sections called are not to answer this call, receipt for this message, or otherwise transmit in connection with this transmission. When this proword is employed, the transmission shall be ended with the proword OUT.
FROM	The originator of this message is indicated by the address designation immediately following:
I AUTHENTICATE	The group that follows is the reply to your challenge to authenticate.
I READ BACK	The following is my response to your instructions to read back.
I SAY AGAIN	I am repeating transmission or portion indicated.
I SPELL	I shall spell the next word phonetically.
I VERIFY	That which follows has been vertified at your request and is repeated. (This proword is to be used only as to reply to VERTIFY.)
MESSAGE	A message which requires recordings is about to follow. This proword is transmitted immediately after the call. (This proword is not used on nets employed primarily for conveying messages. It is intended for use when messages are transmitted on tactical or reporting nets.)
OUT	This is the end of my transmission to you and no answer is required or expected.
OVER	This is the end of my transmission to you and a response is necessary. Go ahead; transmit.

Proword	Meaning
READ BACK	Repeat this entire transmission back to me exactly as received.
RELAY (TO)	Transmit this message to all addressees or to the address designations immediately following.
ROGER	I have received your last transmission satisfactorily.
SAY AGAIN	Repeat all of your last transmission. Followed by identification data means "Repeat ________________ (portion indicated).
SILENCE LIFTED	Silence is lifted. (When an authentication system is in force, the transmission imposing silence is to be authenticated.)
SPEAK SLOWER	Your transmission is at too fast a speed. Reduce speed of transmission.
THIS IS	This transmission is from the station whose designation immediately follows.
TIME	That which immediately follows is the time or date-time group of the message.
TO	The addressees whose designations immediately follow are to take action on this message.
UNKNOWN STATION	The identify of the station with whom I am attempting to establish communication is unknown.
VERTIFY	Vertify entire message (or portion indicated) with the orginator and send correct version. (This proword is to be used only at the discretion of or by the addressee to which the questions message was directed.)
WAIT	I must pause for a few seconds.
WAIT OUT	I must pause longer than a few seconds.
WILCO	I have received your message, understand it, and will comply. (This proword is to be used only by the addressee. Since the meaning of ROGER is included in that of WILCO, the two prowords are never used together.)

Proword	Meaning
WORD AFTER	The word of the message to which I have reference is that which follows __________________.

WORD BEFORE	The word of the message to which I have reference is that which precedes ________________.
WORDS TWICE	Communiction is difficult. Transmit(ting) each phrase (or each code group) twice. (This proword may be used as an order, as a request, or as information.)
WRONG	Your last transmission was incorrect. The correct version is ____________________________.
AFFIRMATIVE	Yes, or permission granted.
NEGATIVE.	No, or permission denied.

NOTE: All message precedences are prowords and are listed in ACP 125 (D). AFFIRMATIVE and NEGATIVE are not listed as prowords; they are normally referred to as operating words.

12-14. PHONETIC ALPHABET AND NUMERALS.

a. The phonetic alphabet is used extensively in radiotelephone transmissions and is included for ready reference.

PHONETIC ALPHABET

Letter	Spoken as	Letter	Spoken as
A	AL FAH	N	NO VEM BER
B	BRAH VOH	O	OSS CAH
C	CHAR LEE or SHAR LEE	P	PAH PAH
D	DELL TAH	Q	KEH BECK
E	ECK OH	R	ROW ME OH
F	FOKS TROT	S	SEE AIR RAH
G	GOLF	T	TANG GO
H	HOH TELL	U	YOU NEE FORM or OO NEE FORM
I	IN DEEAH	V	VIK TAH
J	JEW LEE ETT	W	WISS KEY
K	KEY LOH	X	ECKS RAY
L	LEE MAH	Y	YANG KEY
M	MIKE	Z	ZOO LOO

b. The numerals are transmitted by radiotelephone, the following rules for their pronunciation will be observed.

Numeral	Spoken as	Numeral	Spoken as
0	ZE RO	5	FIFE
1	WUN	6	SIX
2	TOO	7	SEV EN
3	TREE	8	AIT
4	FOW ER	9	NIN ER

c. Numerals will be transmitted digit by digit except that exact multiples of thousands may be spoken as such. However, there are special cases, such as anti-air warfare reporting procedures, when normal pronunciation of numerals is prescribed and this rule does not apply. For example, 17 would then be seventeen.

Numeral	Spoken as	Numeral	Spoken as
44	FOW ER FOW ER	1478	WUN FOW ER SEV EN AIT
90	NIN ER ZE RO	7000	SEV EN TOU SAND
136	WUN TREE SIX	16000	WUN SIX TOU SAND
500	FIFE ZE RO ZE RO	182681	AIT WUN TOO SIX AIT WUN

APPENDIX A

GLOSSARY OF COMMUNICATION TERMS

GLOSSARY: All terms are listed in alphabetical order (based on the primary word in the term).

A

Adjacent Channel - The channel immediately above or below the assigned channel.

Alternating Current - (Abbr: AC) An electric current that is constantly changing in amplitude and periodically changing in direction.

Amplification - The process of increasing the electrical strength of a signal.

Amplitude - The highest value a varying quantity (such as alternating current) reaches as it starts from a reference value (such as zero) and increases in value in one direction.

Amplitude Modulation - (Abbr: AM) A method of modulating a carrier wave to cause it to vary in amplitude corresponding to the amplitude of the original signal. This resultant amplitude - modulated waveform contains the original carrier and the intelligence in the form of sideband frequencies. The frequency of an amplitude - modulated signal does not change.

Antenna - (Abbr: ANT) The portion, usually wires or rods, of a radio transmitting or receiving station, for radiating waves into space or receiving them from space. Also called Aerial.

Antenna - (Ommi - Directional) An antenna which radiates equal power in all directions in a horizontal plane.

Antenna - (Uni - Direcetional) An antenna which radiates most of its power in one direction.

Audio - A Latin word meaning "I hear." Normally relates to frequencies capable of being heard.

Audio Frequency - (Abbr: AF) A frequency corresponding to a normally audible sound wave; about 20 to 20,000 hertz per second.

Authenication - A security measure designed to protect a communication system against fraudulent transmissions.

Automatic Retransmission - The receiving of a signal and automatic relay of that signal on a different frequency between two different stations.

B

Barrage Jamming - This is the transmission of a wide-band signal to interfere with as many channels as possible.

Brevity Code - A code which provides no security but which has as its sole purpose the shortening of unclassified phrases, sentences or group of sentence frequently employed, rather than concealment of their content. The vocabulary may remain in effect for an indefinite period of time. This type of code must be used with the numerical code to provide security.

C

Calibration - The process of comparing an instrument or device with a standard to determine its accuracy.

Carrier Wave - A wave which may be marked or modulated either by changing its amplitude, frequency, or phrase so that it may "carry" intelligence.

CEOI - Communications Electronics Operation Instructions.

Challenge and Reply - In authentication, a procedure by means of a prearranged system whereby one radio operator requests authentication of another radio operator (the challenge) and the latter by a proper reply established its autenticity (the reply).

Channel - A Radio frequency assigned to a radio station.

Coaxial Cable - A cable in which one conductor is centered inside another. Used primarily for the transmission of telephone, radio and television signals.

Code - (1) Any system of communication in which random groups of letters or numbers are used as a substitution for plain text meanings. Codes may be used for brevity or for security.

(2) A code book (or document), containing a list of letters, words, phrases or sentences each accompanied by one or more groups of symbols that can be used as substitutes for plain text meanings.

Code Brevity - A code which is used with the material code to shorten a message and conceal its meaning.

Code Group - A combination of alphabetical or numerical symbols assigned to be substituted for plain text element to be transmitted.

Common Battery - Usually refers to a telephone system where one central battery is used rather than a local battery at each telephone.

Communication Center - An installation providing various communication facilities for a supported unit.

Communications Security (COMSEC) - The protection resulting from all measures designed to deny to unauthorized persons information of value which might be derived from the possission and study of telecommunications, or to mislead unauthorized persons in their interpretations of the results of such study. Communications security includes cryptosecurity, physical security, and transmission security.

Compromise - The knowledge or belief that classified material has been captured, stolen, lost or exposed to observation and study by the enemy.

Comsec Custodian - The individual designated by proper authority to be responsible for the custody, handling, safeguarding and destruction of Comsec Material.

Conductor - A material capable of carrying an electric current, usually a wire.

Continuous Wave - (Abbr: CW) Radio waves having a constant amplitude and a constant frequency.

Counterpoise - A conductor used as a substitute for ground in an antenna system.

Cryptanalysis - The steps and operations performed in converting encoded messages into plain text without previous knowledge of the method used to encode the message.

Cryptoequipment - Any communications security equipment which converts information for transmission to a form which is inintelligible to an unauthorized interceptor, or which reconverts such information to its original form for authorized recipients.

Cryptomaterial - All material, including documents, devices, equipment. and apparatus needed for encoding, decoding, or authentication of telecommunications. When classified, it is designated CRYPTO and subject to special safeguards.

Cryptosecurity - That component of communications security which results from the provision of technically sound cryptosystems and their proper use.

Crystal (Abbr: Xtal) A material, usually natural quartz, which vibrates at a fixed frequency. It is used in electronic equipment to maintain an accurate frequency.

Cycle - One complete wave of alternating current which changes from zero to positive, negative, and back again.

D

Date-Time-Ground (Abbr: DTG) - The date and time, expressed in numbers representing the date and time that a message was prepared for transmission. (Expressed as six digits the first pair digists denoting the date, second pair the hours, third pair the minutes i.e., 041145), the fourth day of the month (04), at 1145 hours.

Direct Current - (Abbr: DC) Electric current that is constant in amplitude and direction.

Duplex - A method of operation of a communication circuit where a station can transmit and receive simultaneously. Ordinary telephones are duplex. When used on a radio circuit duplex operation requires two frequencies.

E

Electromagnetic Field - A magnetic field resulting from the flow of electricity.

Electronic Counter-Countermeasures (ECCM) Defensive Actions taken to ensure effective use of radio and radar equipment despite the enemy's use of Electronic Warfare.

Electronic Countermeasures (ECM) - Actions taken to jam our radio and radar signals and deceive our radio and radar operators.

Electronic Warfare - (EW) EW is military action involving the use and exploitation of radio and radar signals to gain information, locate units and disrupt the commnad and control of military forces on the battlefield.

Electonic Support Measures (ESM) Actions taken to search for, intercept, locate, monitor, record, and analyze radio and radar signals.

Encode - Using National Security Agency (NSA) approved codes and equipment to place plain test messages into a good form for transmission.

F

Facsimile - Radio or wire communication by which printed pages are transmitted and received.

Fading - Variation in the strength of a received radio signal, usually caused by interference of received waves passing over different transmission paths.

Frequency - The repetition rate of radio wave commonly stated in hertz, kilohertz or megahertz per second.

Frequency Modulation - (Abbr: FM) An electrical method of communicating by lengthening and shortening the transmitting time of radio waves.

G

Ground Wave - A radio wave which reaches a distant station by traveling along the earth's surface rather than through te earth's upper atmosphere.

H

Hertz - A unit of frequency equivalent to one cycle per second.

I

Imitative Deception - Transmitting false radio message or radar signals to deceive radio and radar operations and disrupt command and control.

Interception - The act of searching for and identifying radio and radar frequencies of operation.

Insulation - Non-electrical material place around electrical wires to keep the electricity from leaving the wires and traveling to other conducting material.

Interference - Disturbance in radio/radar reception caused by unwanted signals being received by the radio/radar equipment.

J

Jack - The stationary part of a circuit connector. With its counterpart, a plug, it is used to connect or disconnect electrical circuits.

Jamming - Intentional tranmission of radio signals in such a manner as to interfere with the reception of signals from another station.

Jumper - A short length of wire used to reconnect two points in a circuit.

K

Kilohertz - (Abbr: KHz) A frequency of one thousand hertz.

L

Line of Sight - The unobstructed or optical path between two points.

Link (Radio) - A transmitter-receiver system connecting two locations.

Listening Silence - A radio operating condition wherein the radio receiver is operating and the transmitter is not employed.

Local Circuit - A wire circuit connecting a telephone to a switchboard.

M

Megahertz - (Abbr: MHz) One million hertz.

Monitor - To listen to transmissions.

N

NCS- (Net Control Station) has technical control of a radio net.

Net - An organization of stations capable of direct communications on a common channel/frequency.

Noise - Any uninteligible signals in a communication system which tend to interfere with proper reception of the desired signals or speech.

Null - A minimum or zero value of current in an electrical circuit.

O

Open Circuit - An electrical circuit that is broken.

Operations Code - That is composed of three letter code groups that are substitutions for letters, numbers, words, and phrases.

P

Physical Security - That part of security concerned with physical measures designed to safeguard equipment, facilities, material and documents, against espionage, sabotage, damage and theft.

Precedence Designations - Precedence Designations, from highest to lowest for the handling of message, are as follows:

a. Flash.

b. Immediate.

c. Priority.

d. Routine.

Q

Quarter-Wave Antenna - An antenna whose electrical length is one-quarter the wave-length of the signal to be transmitted or received.

R

Radar - Application of radio principles in order to detect the presence of an object, their character, direction and distance. The word is derived from the term Radio Detection and Ranging.

Radiate - To send out energy such as a radio signal.

Radio Channel - A frequency alloted to a radio net for radio communications.

Radio Direction Finding - Determining the direction to a radio transmitting location. Only the direction of a station is determined by means of its transmissions. This can be accomplished by only on DF station.

Radio Fix - The location of a friendly enemy radio transmitting antenna, determined by finding the direction of the radio transmitter from two or more direction finding stations.

Radio Spectrum - The frequencies which may be used for the transmission and reception of radio signals.

Radio Silence - A condition in which both the radio receiver and transmitter are not to be used. The radio set is turned off.

Radio Wave - An signal produced by rapid reversals of current in a conductor. Such a wave travels through space at approximately the speed of light.

Radio/Wire Integration - A communication technique where a radio can be completed by innerconnection to a wire network.

Range - The approximate distance over which a radio or telephone transmitter is useful.

Retransmission (Radio) - A radio installation between any two or more radios that automaticaly relays the transmitted messages. Also called Radio Relay.

Signal - Electrical energy produced and used to convey messages and information.

Signal Intelligence (SIGINT) - Gaining intelligence information by monitoring communications and other electrical signals.

S

Simplex - A method of operation of a communication circuit where each end can only receive or transmit, not both simultaneously . The usual "push to talk" operation.

Sound-Powered Telephone - A telephone energized by the sound waves of the voice, with no external power supply. The current impulses are generated in the circuit by the sound waves on teh microphone.

Spot Jamming - Transmitting a jamming signal of a narrow band of frequencies usually of a band-width slightly more than that of the target signal.

Squelch Circuit - A radio circuit which reduces background noise in the absence of signals.

Static - Noise, heard in a radio receiver caused by electrical disturbances such as lightning, electrical generators, power lines, etc.

Subordinate Station - Lower ranking station in a radio net.

Sweep Lock-On Jamming- A jamming system that sweeps a wide range of frequencies with a receiver. When a signal is detected, the sweep stops and jammer is activated.

Sweep Jamming - Transmitting a narrow band of jamming signal but turning it continuously over a wide range of frequencies.

T

Teletypewriter - A teleprinter which prints the messages in page form and can also be used to transmit messages by standard typing methods.

Traffic Analysis (T/A) - A branch of cryptology which studies signal transmissions.

Transceiver - A radio transmitter and receiver combined in one unit.

Transmission Security - That component of communication security which results from all measures designed to protect transmissions from interception and traffic analysis.

Transmitter - That portion of a radio that produces and sends radio signals.

Tuned - Adjusted to operate at a specific frequency.

Twisted Pair - Two insulated wire conductors twisted together.

V

Variants - Two or more coded groups which have the same plain language meaning.

Watt - A unit of measurement of electrical power.

Wavelength - The distance in meters traveled by a wave during one complete cyle. It is equal to the velocity divided by the frequency.

244.

Appendix B

Joint Communications-Electronics Equipment Designation System

All Army, Navy, Air Force, and Marine Corps signal equipment can be identified by the nomenclature system described in figure 4-4. The letters "AN" appearing as the first two letters of the nomenclature are the system indicator and mean that the joint designation system was used in arriving at the nomenclature and that the item is a complete end item. The letters that follow the system indicator describe the installation, the type of equipment, and the purpose of the equipment. The numbers that follow the letters indicate the model number of the equipment.

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